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TEACHERS' INQUIRY-BASED MATHEMATICS IMPLEMENTATION IN RAPID CITY AREA SCHOOLS: EFFECTS ON ATTITUDE AND ACHIEVEMENT WITHIN AMERICAN INDIAN ELEMENTARY STUDENTS

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by

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Project PRIME (Promoting Reflective Inquiry in Mathematics Education), was funded by the National Science Foundation in October 2002. Implementation subsequently began in 2003 and focused upon K-12 mathematics education within Rapid City, South Dakota Area Schools (RCAS). One goal of the project has been to reduce the achievement gap between Native American and non-native students enrolled in RCAS. At the elementary level, this gap reduction was to be achieved through promoting broader use of inquiry-based mathematics, strategies that have been shown elsewhere to help struggling math students in general (Baxter, Woodward, & Olsen, 2001; Franke, Carpenter, Levi, & Fennema, 2001; Kazemi & Franke, 2004) and Native American students in particular (Demmert, 2001; Hankes, 1998; Nelson-Barber & Estrin, 1995). This ethnography of education policy implementation (Hamann, 2003; Levinson & Sutton, 2001; Muncey & McQuillin, 1996) focused on whether through Project PRIME, inquiry-based mathematics strategies were consistently implemented in the three K-5 elementary schools with a significant Native American student population in RCAS and only then considers whether Project PRIME and RCAS can be used to extend or challenge the existing understanding that inquiry-based mathematics might be particularly advantageous to Native American students.

This study examined 5th grade classrooms during the 2008-2009 year as these students have been the target of Project PRIME the longest; the vast majority of 5th grade RCAS students should have been involved with inquiry-based mathematics for most of their elementary years (if intended implementation was enacted). Implementation at the three high-Native American enrollment schools was then compared with a fourth elementary school that had a lower Native American student population but was considered an exemplar of inquiry-based mathematics by RCAS and Project PRIME leadership.

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I: INTRODUCTION

In brief, through this dissertation I ask: What are the strategies that will be most effective in improving mathematics teaching and learning for American Indian children in Rapid City, South Dakota, and are these strategies consistently implemented in the elementary schools with a significant American Indian population? I pursued this question by looking first at what the literature says about effective mathematics instruction with American Indian students and posing a hypothesis about how such education might become more commonplace, second by illustrating how the design of Project PRIME (an initiative in Rapid City Area Schools (RCAS)) aligns with the recommended practices in the literature, third by considering Project PRIME as it is actually being carried out, and finally by looking at how Project PRIME (as both designed and practiced) might be salient to the larger task of mathematics education with American Indian students in general.

Acknowledging that different authors make conflicting recommendations about 'most appropriate' terminology, I use the terms American Indian and Native American interchangeably. As McCarty (2008) acknowledges many terms exist for Native peoples in the United States – i.e., American Indian, Alaska Native, and Native American, Native Hawaiian – and all of these refer less to subjective self-identifications by members of these groups than to the federal government's acknowledgement of the unique status of Native Americans (p. 180).

Background of the Problem

In January 2002, President Bush's signing of the revision of the Elementary and Secondary Education Act (better known as the No Child Left Behind Act of 2001-

NCLB) added to the pressure on states and K-12 public schools to raise student achievement, particularly in mathematics and reading. The legislation identified as a central interest in the "closing the achievement gap" that has long existed between "minority" and "nonminority" and "disadvantaged" and "more advantaged" students (Ellis, 2008, p. 4). Through NCLB, which was still the prevailing federal education mandate at the time of my study, states (hence public school districts) that rely upon federal funds have been held accountable for student academic achievement; they must report student progress in terms of percentage of students scoring at the "proficient" level or higher to determine whether a school met adequately yearly progress (AYP) (Abedi, 2004, p. 4).

The policies of NCLB leverage and intensify the "dividing practices" instituted in the early 20th century as a justifying means for the differential stratification of students in schools (Ellis, 2008). But according to Rick Melmer, Secretary of Education in South Dakota in 2007, an outcome of NCLB was that the disaggregated data of state test scores allowed comparisons to be made between cultural groups more effectively than in previous years. More specifically, he noted that because of NCLB the achievement of American Indian students in South Dakota could be more accurately compared to Caucasian students, thereby illuminating the stark achievement gap between the two groups and the need for better practice (South Dakota Indian Education Conference, 9/23/07).

Statement of the Problem

RCAS enrolls approximately 13,000 students, making it the second largest district in the state. RCAS includes 15 elementary schools, 5 middle schools, and 3 high schools, and employs approximately 500 teachers of mathematics (including elementary and special education teachers). Rapid City enrolls the largest off-reservation population of Native American students in South Dakota (Sayler & Apaza, 2006). Using fifth grade as a point of reference, 36% percent of those students qualify for free or reduced-price lunch, 22% are non-white (17% American Indian, 5% other non-white groups).

In 2003, 49% of 5th students enrolled in RCAS scored proficient or above (6% advanced, 43% proficient) on the Dakota State Test of Educational Progress (Dakota-STEP) Math. By 2008, the percentage for the same group had risen to 73% (16% advanced, 57% proficient) for the district (retrieved from https://sis.ddncampus.net:8081/nclb/index.html). In 2003 the RCAS achievement gap between white and American Indian 5th grade students at the advanced or proficient level was 31%, but in 2008, the achievement gap at the advanced or proficient level decreased to 24% (retrieved from https://sis.ddncampus.net:8081/nclb/index.html). However, a gap of 24% is still large; the gap resulted from the fact that 77% of white students were proficient or advanced but only 53% of American Indian students achieved at or above the proficient level (retrieved from https://nclb.ddncampus.net/nclb/portal/portal.xsl?&extractID=10).

Looking from the advanced category only, in 2003 7 % of white students scored at that level and 1 % of Native Americans reached that level. However, in 2008, both groups posted gains from their 2003 percentages. In 2008, 18% of white students scored at the advanced level and 5% of Native Americans scored at the same level. An indication of student achievement increases for both groups is promising. The achievement gap has been slightly diminished while scores for both groups increased.

The task of serving American Indian students better in schooling in general, and in mathematics in particular, is a complex issue (Tambe et al., 2007). What are the strategies that will be most effective in improving mathematics teaching and learning for American Indian children in Rapid City, South Dakota, and are these strategies consistently implemented in the elementary schools with a significant American Indian student population?

One portion of NCLB calls for schools to hire highly qualified teachers for every mathematics classroom. According to the legislation, "highly qualified" is defined as full certification, a bachelor’s degree, and demonstrated content knowledge in all core subjects taught (Smith, Desimone, & Ueno, 2005, p. 75). This raises the questions: Does the extant definition of ‘highly qualified’ correlate with student achievement? And are ‘highly qualified’ teachers necessarily highly qualified to teach Native American students? Ma (1999) argued that a highly qualified mathematics teacher must have a fundamental knowledge of mathematics, and a number of scholars since have substantiated this claim (Ball, Hill, & Bass, 2005; Ball, Lubienski, & Mewborn, 2001, Cohen & Hill, 2000). Yet a teacher can be supposedly ‘highly qualified’ without knowing strategies and dispositions that make it more likely that American Indian students in their classroom will succeed.

Today’s educators, who are primarily white middle class females (Howard, 2003), must not only possess a fundamental knowledge of their content, but, per a constructivist understanding of teaching and learning, they must also be cognizant of what knowledge and issues their students bring to their mathematics classroom. Ninety percent of the teachers were white females in the four RCAS elementary schools I studied, and many in the remaining ten percent are not necessarily familiar with Native culture. In other words, the backgrounds and lived experiences of the large majority of elementary teachers are different from their American Indian students. This does not mean that Native American students cannot learn from white teachers, but it does seem hazardous to assume that the white teacher to the Native American student learning interface is as likely to be successful as the white/white interface absent overt efforts. Research supports the idea that Native American children, as children of all ethnicities – are better served by teachers who look like them and share their cultures and languages (Vandergriff, 2006, p. 1).

Like a long list of others, Downey and Cobbs (2007) assert that majority culture teachers may fail to understand minority culture students' perspectives, cultural values, ways of knowing, and learning needs, creating a mismatch between the perspectives, values, and understandings of students and their families, on the one hand, with those promoted by the routine practice of schooling on the other. Sadly, few teachers recognize American Indian students' knowledge or their considerable learning strategies (Nelson-Barber & Estrin, 1995).

Starnes (2006) claimed that solid teaching skills, good intentions, hard work, and caring for kids are not enough to cross the divide when teachers and students come from different cultural traditions; perhaps reflecting the general invisibility of 'whiteness' to many whites (Delpit, 1988, 1995; Hall & Parker, 2007; Sleeter, 2001). White teachers do not always recognize the chasm that exists between their students' needs and traditionally accepted curricula and methodology. Instruction can be difficult for even the most skilled and dedicated white teachers to teach effectively if they know little about the history, culture, and communities in which they teach. What white teachers do know has usually been derived from a white-dominated education experience which does not necessarily address minority students well (Delpit, 1988, 1995; Leiding, 2006).

Lomawaima (2000) recently stated that the need for quality research in American Indian education is pressing. Fortunately, in spite of a paucity of funding and coordinating efforts, a research base has emerged to address American Indian students' learning styles and generating evidence of *what works* to improve the academic performance of indigenous students (e.g., Demmert, 2001; 2003; Deyhle & Swisher, 1997; Pewewardy, 2003). But Demmert (2005) contends that our ability to understand the problems faced by Native American students in today's educational system is severely limited by the lack of information regarding the education of this particular sector of society. According to Lipka (1991), whose career has focused on developing culturally relevant concept-based mathematics, for teachers to effectively instruct minority students they must possess an in-depth understanding of the content within the culture and also share culturally determined communication styles and values.

Applying these findings to the context of RCAS, the mismatch between mainly white female teachers and the large enrollment of American Indian students requires overt efforts at bridging differences. Otherwise that difference will likely prove deleterious for American Indian students, as illustrated by achievement gaps.

Statement of the Primary Research Question and Hypothesis

<u>Primary research question:</u> **What are the relationships between teacher attitudes toward implementing an inquiry-based mathematics curriculum, their**

actual implementation, and the achievement of Native American elementary schools students in RCAS?

Underlying hypothesis: **Native American students enrolled in Rapid City elementary classrooms whose teachers have fully embraced inquiry-based mathematics implementation will exhibit higher achievement in mathematics than Native American students whose teachers have been resistant to change their teaching methods because an inquiry approach lends itself to building on the cultural knowledge and awareness that students bring with them into the classroom.**

Subquestions

a. **What relationship do Rapid City elementary teachers perceive between the teaching and learning of mathematics and a student's race and culture?**
b. **Has participation in Project PRIME increased the confidence and mathematics education efficacy of Rapid City elementary teachers that serve an American Indian population?**
c. **What continuities and discontinuities exist between what is provided to build teachers' mathematical and pedagogical capacity to use inquiry-based mathematics through professional development and what actually happens in the classroom?**
d. **Do years of experience have an effect on teachers' attitude toward both equity and inquiry-based mathematics?**
e. **As part of an effort to consider *how* teaching experience affects teacher attitude, which group of teachers is more agreeable to make the necessary changes to implement inquiry-based mathematics?**

Importance of the Study

Teaching is a contextual and situational process that is most effective when ecological factors, such as prior experiences, cultural backgrounds, ethnic identities, and community settings are attended to in its implementation (Gay, 2000). Good education for *all* children involves finding ways to recognize and build upon students' prior experiences and prior knowledge (Gutstein et.al, 1997; Tambe et al, 2007), but because children's culturally mediated prior experiences and knowledge will differ, good instruction will look different, at least in its particulars, with different students and groups of students.

Additionally, standards-based mathematics reform adoption and adaptation of National Council of Teachers of Mathematics (NCTM) standards by states and district further increases the urgency of understanding the language of policy implementation (Hill, 2008, p. 66). Significant demands have been placed on teachers to transform their teaching practice from a teacher-presentation-student-recitation model to a student-centered model, where students explore, reason, and openly communicate with each other (Hill, 2008, p. 66). Likewise, management and implementation strategies are directly related to the quality of professional development activities provided to teachers (Desimone, Porter, Birman, Garet, & Suk Yoon, 2002).

The National Council of Teachers of Mathematics [NCTM] *Principles and Standards for School Mathematics* (2000) positioned *equity* at the forefront of the principles for school mathematics. Gutierrez and Lubienski (2008) view equity as one of the highest priorities in mathematics education. Too few teachers have adequate knowledge of how teaching practices reflect European-American cultural values (Delpit, 1988, 1995; Ladson-Billings, 1997; Zevenbergen, 2000). The most common explanation for group differences in young children's mathematics knowledge proposes that differences are largely superficial (Guberman, 1999). As Ladson-Billings (1997, p. 700) and Guberman (1999) have noted, some suggest that mathematics is *universal* and thus *culture free* and it does not matter who is doing the mathematics because the task remains the same. But when the culture and knowledge of the students in classrooms is different from that represented in the curriculum, there is a greater likelihood of a mismatch between what is seen as relevant and meaningful between the students and teacher (Zevenbergen, 2000).

In the past decade, research on reform-oriented materials has become more available than when the original NCTM *Curriculum and Evaluation Standards* (1989) were published. Lubienski (2006) used hierarchical linear modeling with National Assessment of Educational Progress (NAEP) 4^{th} grade mathematics data to examine relationships between reform-oriented practices and student achievement. Her study determined that teachers' emphasis on non-number mathematics strands, team problem solving, and teachers knowledge of the NCTM standards were positive indicators of student achievement (p. 20). Her study, however, did not investigate whether these findings held to the same degree for students from different cultural groups and identities.

II. Theoretical Framework (aka Why this Research Matters)

This chapter provides a brief history of Indian schooling, which has been often more problematic than successful. Then background information on standards-based (inquiry-based) mathematics is provided in the chapter before research is presented that provides evidence that inquiry-based mathematics should present a more effective learning method for Native American Students. To provide other key background information, I also provide a description here of cognitively guided instruction and the development of Project PRIME.

A Brief History of Indian Education

To understand why Native American math education might be an issue in RCAS, it is worth paying at least brief attention to the history of Native American and Alaskan Native education (and miseducation). In the 1800s, the United States federal government initiated a charge to 'civilize' the indigenous people of America with schooling as one vehicle for that effort. Believing that their way of life, religious doctrines, and secular knowledge about the world were "correct," the white men felt it was their duty to help guide (or force) others into their way of thinking (DeLoria, 1999). Stimulated by the efforts of U.S. Army Captain Richard Henry Pratt in 1870 (Pratt, 1964; Szasz, 1999), industrial boarding schools were funded by the U.S. Congress to school Native Americans and separate Indian children from their parent's 'savagery.' The goal was to take the 'Indian' out of the Indian students (Reyhner & Eder, 1992). From the very first then, U.S. schooling of Native American children was intended to overcome or erase a students' background, rather than build on it. In a word, it was assimiliationist, with assimilation defined as a unidirectional movement from membership in one culture to membership in another (Grey, 1991).

Unlike assimilation, acculturation is a two-way dynamic process between groups or individuals who come into direct contact and develop a symbiotic relationship. It does not require a change in values, although values may be adopted. Acculturation is a necessary, but not sufficient condition for assimilation to transpire, as a change in values is required (Teske & Nelson, p. 365, 1974). The results of acculturation include acceptance, adaptation, and sometimes reaction (Redfield, Linton, & Herskovits, 1936).

Proponents of Indian assimilation saw public schools as a solution to the Indian education *problem* and at the start of the twentieth century Indian children were placed in public schools (Szasz, 1999), although the boarding school model also persisted. After the 1887 General Allotment (Dawes) Act whites responded eagerly to the newly available leases on reservation land, and they brought with them demands for public schools for their children (DeLoria, 1999; Lomawaima & McCarty, 2006; Reyhner, 1992). By 1912 there were more Indian students in public schools than in government boarding schools and the number of government schools began to decline (Reyhner & Eder, 1992).

The Meriam Report

In the mid-1920's amid mounting criticism of corruption within the Indian Education Office, the Institute for Government Research, a nongovernmental research organization, organized and funded a research team led by Lewis Meriam (Lomawaima & McCarty, 2006; Starnes, 2006). The team published *The Problem of Indian Administration,* commonly known as the Meriam Report (Meriam, et. al., 1928 as cited in Lomawaima & McCarty, 2006). That report is still seen by many as the most complete analysis ever done of federal policies' impact on Native Americans (Lomawaima & McCarty, 2006, Szasz, 1999, Starnes, 2006).

Although about more than just schooling, the Meriam report identified education as the keystone to effective administration of "Indian affairs" and offered an alternative to the long-standing assumption that assimilation was the only option for Native people (Lomawaima & McCarty, 2006, p. 65). The study highlighted the need for bicultural education that was less formal and that avoided highly mechanical content handled in a highly mechanical way (Starnes, 2006).

John Collier

What Native American education scholars refer to as 'the era of John Collier' began in 1933 (Szasz, 1999). Appointed by Franklin Delano Roosevelt to lead the Bureau of Indian Affairs (BIA), John Collier is now remembered as one of the most prominent early Anglo proponents for Native American rights. He immediately sought to implement the recommendations of the Meriam report, campaigning successfully for the Indian Reorganization (Wheeler-Howard) Act of 1934 (Deloria, 1974; Reyhner & Eder, 1992).

However, a concern for the education of Indian children was a missing component in the Wheeler Howard Act and it seemed evident that this confusion represented preliminary efforts of the federal government to escape the burden of providing educational services to Indians by any means possible (DeLoria, 1999, p. 166). Many reservation parents were faced with the complex task of how to maintain schools without adequate funds (Szasz, 1999).

Collier observed that the "crucial" funding for Indian services continued to shrink. As a result, he said, schools "are being expected to carry nearly the whole load of the work of Indian betterment, while the medical system is coerced in the direction of costly institutional work as distinct from public health work, and health education" (Collier, 1944, as cited in Szasz, 1999).

In 1933, Collier traveled to the Rosebud Reservation in South Dakota to explain his plans for an Indian New Deal. He made it clear that he respected Indian ways and felt that both the old and new were needed (Biolsi, 1992, ix). Collier attempted to extend to the tribes self-determination without any limit beyond the need to advance by stages to the political, economic, and cultural *decolonization* of Indian people through the Indian Reorganization Act (Biolsi, 1992, xx). Collier envisioned a plan of indirect rule similar to British colonial policy whose proper function is 'evocation' rather than imposition (Collier as cited in Biolsi, 1998, p. 126). Although it was not in the remit of Collier to worry about schooling of Native American children in Rapid City three generations in the future (obviously), his legacy of assuming that government policy's orientation for Indian betterment needed to be responsive to those same Indians matters to our RCAS case. Inquiry-based math, as I will explain more later, assumes that students will help determine how they learn and how they tie their new learning to existing knowledge.

Johnson-O'Malley Act

In addition to the Indian Reorganization (Wheeler-Howard) Act of 1934, the Johnson-O'Malley (JOM) Act was passed that same year, which authorized the secretary of the interior to enter into contracts with states or territories and compensate them for providing services to Indians (DeLoria & Wildcat, 2001; Lomawaima, 1995, 2003; Reyhner & Eder, 1992; Sharpes, 1979; Szasz, 1999). JOM replaced a complex system of contracting between BIA and individual school districts to allow for the enrollment of Native students in public schools. JOM, which seemed to point in a different direction than American Indian self-determination, was based on the assumption that (non-Indian) federal and state administrators could work together toward a common goal (Szasz, 1999). The JOM became famous as a pool of money ostensibly to help Indian children which in fact came to be used in many states for non-Indian schools *(An Even Chance,* 1971). The structural abuses of the administration of the Act were not exposed until the wave of Indian leadership of the 1960s came on the scene (Lynch & Charleston, 1990).

Since 1975, legislation has mandated parent involvement when public schools use either JOM or Title VII funds; nonetheless, Indian communities still fight to see that such involvement occurs (Robinson-Zanartu & Majel-Dixon, 1996).Today, the JOM Act still provides money to public schools educating Indian children (Lomawaima, 2003), but current JOM programs must be supplemental in nature and be approved by an Indian Parent Advisory Committee (Reyhner, 1992).

NCLB did not include provisions for JOM. Rather, in 2006, the Bush Administration proposed *termination* of JOM because of duplication of other federally supported programs such as Title VII of NCLB. The U.S. House of Representatives admonished the Bush Administration for this claim along with the National Congress of American Indians (retrieved from http://www.ncai.org/ncai/resolutions/doc/SAC-06-072.pdf).

The RCAS Office of Indian Education (OIE), works closely with a Parent Advisory Council (PAC). The PAC meets monthly during the nine-month school year at different venues within the district (retrieved on March 1, 2009 from http://www1.rcas.org/indianed/ie_index.htm).

Rough Rock and Self-Determination

The greater governmental receptiveness to including Native Americas as partners in education is evident in an important example that originated in the 1960s. In an attempt to have a school they could call their own (Reyhner & Eder, 1992), a Navajo bilingual/bicultural demonstration project jointly funded by the Navajo Office of Economic Opportunity (OEO) and the BIA eventually led to a new BIA school facility at Rough Rock, Arizona and quickly rose to international prominence as a model of Indigenous self-determination (Lomawaima & McCarty, 2006; McCarty, 2002; Roessel, 1968; Sharpes, 1979).

In the early days of Rough Rock a visitor might find nearly 100 parents at the school visiting the classrooms, taking part in school programs, working in the dormitories, and really participating in the school (Roessel, 1968). Explicitly bilingual, the school privileged the local language and culture and carried principles of kinship into the dormitories and other school services (McCarty, 2002). Robert Roessel, the first head of the school, claimed the Navajo cultural instruction was successful, although the school suffered from a dearth of Navajo print materials and the presence of Anglo-centric texts and the transmission-oriented pedagogies (McCarty, 2002).

Other Native American communities watched Rough Rock with interest (Lomawaima & McCarty, 2006) and contract schools were developed elsewhere in the American West that became symbols of local control – e.g., Rocky Boy, Wind River, Red Cloud and Ramah (Sharpes, 1979). However, no blueprints existed for doing school in the manner Rough Rock had demonstrated; the project called upon students, teachers, parents, the school board, and administrators, to blaze a new trail, but within the structural confines of an existing non-Indigenous social-educational system (McCarty, 2002). Shaky government financing of tribally controlled schools continues (Reyhner & Eder, 1992), but in spite of problems, policies of self-determination and local control have led to the training and certification of Indian teachers and the development of local leadership through elected parent committee, school boards, and tribal councils (McCarty, 1989, as cited in Reyhner & Eder, 1992).

Rough Rock is a reminder then, that traditional assumptions that have guided Native American schooling can be overturned. However, in urban areas located off reservations, Native American parents and students are not the majority and the idea that schooling should be explicitly organized to be responsive to Native American students and parents is less likely to win full accommodation.

Rapid City is such an off-reservation, urban, area, yet Rapid City is unique because it is located less than sixty miles from the Pine Ridge Indian reservation. If students' relatives do not live in the Rapid City area, they often live on the nearby reservation. Eighteen percent of the students that attend elementary schools with significant Native American populations are classified as "homeless migrant" because they may live with relatives other than their mother and father in the RCAS district. However, there is also a faction of students who may be enrolled in RCAS for a time and then move to the reservation to live with relatives for awhile. This movement between school districts results in additional challenges to student learning and achievement. It also suggests that for many Native American RCAS students the 'treatment' of engagement with inquiry-based mathematics may be less complete than that of their more geographically stationary white and Native American peers.

On September 28, 2007, the total student population in RCAS was 13,115 and of that number 2,289 were K-12 American Indian students. At that time, 1, 185 were enrolled in elementary schools, 489 were enrolled in middle school, and 606 were enrolled in high school. In the 2007 graduating class, only 45 were American Indian (RCAS Strategic Plan of American Indian Success, 1/22/08).

In 2006, the RCAS Board of Education hired the Redstone Educational Consulting Group to begin working with teachers, administrators, parents and community members to develop a Strategic Plan for improving the quality of education for American Indian students. Included in those goals were a district literacy plan and committed support for inquiry-based mathematics.

Why Inquiry-based Mathematics is Better for Native American Students

What Native American schooling should accomplish has been controversial since the birth of the United States. Although non-indigenous actors such as Henry Pratt, Lewis Meriam and John Collier worked for the betterment of Native American education, an approach of assimilation rather than acculturation has proven to be dominant and more problematic for Native American students. Adoption of a more acculturative (instead of assimilative) approach could aid in promoting high expectations and strong support for all students in the mathematics classroom.

Equity

NCTM’s first *Curriculum and Evaluation Standards* (1989) included equity as a goal of mathematics education reform with a promise of “opportunity for all.” That document’s overlying focus was the preparation of “mathematically literate workers.” In NCTM’s revised *Principle and Standards* (2000), effective teaching is an essential component of equity in mathematics education:

Excellence in mathematics education requires equity – high expectations and

> strong support for *all* students…All students, regardless of their personal characteristics, backgrounds, or physical challenges, must have opportunities to study – and support to learn – mathematics. (NCTM, 2000, p. 12)

This vision of equity in mathematics education challenges the fallacy broadly held in North America that only some people are capable of learning in mathematics (NCTM, 2000). Well-documented examples provide evidence that all children, including those who have been traditionally underserved can learn mathematics when they have access to high quality instructional programs that support their learning (e.g., Lipman & Gutstein, 2000; Lubienski, 2001; Gutstein, 2003; Matthews, 2005; Schoenfeld, 2002).

Further Defining Inquiry-Based and Cognitively-Guided Instruction

Standards-based, reform-curricula, and inquiry-based mathematics are often used interchangeably by scholars; regardless of the name used, the terms originated with the NCTM (1989, 2000) standards documents. Reform curricula emphasizes the *understanding* of the mathematics and claims that learning happens more quickly and readily when *understanding* is the focus of mathematics instruction (Sowder, 1998). Five of the underlying principles of the *Principles and Standards of School Mathematics* (NCTM, 2000) focused on student thinking: problem solving, reasoning and proof, communication, connections, and representations. The NCTM standards consciously incorporated ideas such as constructivism, and about how students acquire personal understanding and skill in mathematics.

The correlating research indicates that reform-exposed students do as well in skills as students exposed to traditional curricula, but they do better on problem solving and understanding concepts (e.g., Battista, 1999; Schoenfeld, 2002). Teaching mathematics for conceptual understanding produces significant results across the board – in skills, concepts, and problem solving (Briars & Resnick, 2000; Gutstein, 2003; Gutstein, Lipman, Hernandez, & de los Reyes, 1997; Kazemi & Stipek, 2001; Schoenfeld, 2002).

Current mathematics education reform emphasizes the importance of teachers applying more conceptual ideas in their teaching and focusing less on traditional procedural and computational strategies such as relying upon algorithms and rote problem solving (Ball, Hill, & Bass, 2005; Cohen & Hill, 2000; Fennema, Carpenter, Franke, Levi, Martins, & Empson, 1996; Fennema, Franke, Carpenter, & Carey, 1993; Hill & Ball, 2004; Hill, Rowan, & Ball, 2005; Hill, Schilling, & Ball, 2004; Kazemi & Stipek, 2001; Ma, 1999; Schoen, Cebulla, Finn, & Fi, 2003). This inquiry-based instruction is advocated in NCTM's revised *Principles and Standards* (2000). At the turn of the 21st century large-scale data evaluating the impact of standards-based (inquiry) curricula became available with the evidence pointing unambiguously in favor of reform (e.g., Goldsmith, Mark, & Kantrov, 2000; Schoenfeld, 2002, 2004; Senk & Thompson, 2003), although that has not meant that places that implement the reform poorly have made it very far (Schoenfeld, 2002). One of the reasons this dissertation is ultimately framed as an ethnography of education policy implementation – a term clarified later – is to overtly consider what 'poor implementation' references; I pursue this point later.

Research indicates an increasing agreement on the benefits of conceptual teaching strategies which are a part of an inquiry-based approach (Carpenter, Fennema, & Franke, 1996; Fennema, et al, 1996; Carpenter, Fennema, Franke, Levi, & Empson, 1999; Hiebert & Stigler, 2004; Kazemi & Stipek, 2001; Ma, 1999). But new and veteran teachers have different means of demonstrating their content knowledge (Smith, Desimone, & Ueno, 2005) which suggests they may implement inquiry-based mathematics to different degrees and with at least somewhat varying conceptions of what inquiry-based mathematics proposes to be.

Cognitively-guided Instruction

Cognitively guided instruction (CGI), one illustration of an inquiry-based approach, was developed by Thomas Carpenter and Elisabeth Fennema through a research project at the University of Wisconsin-Madison in the early 1990s. CGI does not design curricula nor design instruction. The primary goal of CGI is to help teacher acquire knowledge of children's mathematical thinking and then to study how teachers use children's knowledge to design and implement instruction (Hiebert, et al., 1997, p. 14). Not only does this allow the teacher to understand how the student is progressing concerning mathematical thought, but it also allows the students to practice meta-cognition (Schadler, 2008).

Judith Hankes was a doctoral student at the University of Wisconsin-Oshkosh during CGI's development; since then, she has been at the fore-front of research concerning the relationship between CGI and Native American pedagogy as she wrote her dissertation on the topic (Hankes, 1998). CGI is an essential component of Project PRIME; thus Hankes work is particularly relevant.

According to Hankes (1998) both CGI and Native American pedagogy view the teacher as a facilitator who most effectively acts indirectly rather than providing direct instruction to students. Both CGI and Native American pedagogy utilize problem solving, or sense making; i.e. students are allowed to solve problems using methods that make sense to them personally. Problems are based upon the life experiences of the students; they call for cooperation rather than competition, and they are time-generous rather than time driven. Native American pedagogy and cognitively-guided instruction commonalities are provided in Appendix A.

(See Appendix A)

McREL's (2005) exploratory study concerning Plains American Indian students and mathematics looked at differences in the emphasis on mathematical tasks on problem solving, reasoning and making connections; the ratio of teachers' telling statements to questions; the level of cognitive demand in teachers questions; and the sensitivity of the instructional interactions and classroom environment to American Indian culture and heritage. Three approaches to teaching mathematics were selected: Saxon Math, Cognitively Guided Instruction (CGI), and Success for All (SFA) Math Wings. Four Plains schools were involved in the study and the Native American students who participated in the study were from the Lakota/Dakota nations.

The McREL (2005) study found that students who were exposed to CGI and SFA lessons may have had more opportunities to practice and develop mathematical reasoning. The findings suggested further studies on cooperativeness in classroom environments and how teachers effectively use verbal interactions to advance student's mathematical knowledge and skills (p. 38).

Donna Deyhle, a renowned American Indian education researcher who has spent the majority of her career studying the Navajo education and Karen Swisher, past leader of Haskell Indians Nations University in Kansas and also a scholar of American Indian education research, have often jointly conducted educational research on American

Indian students. In one article (Deyhle & Swisher, 1989, pp. 9-10), the pair offered suggestions to inform teachers of American Indian students to improve their practice and relationship with their Indian students that are as timely today as when they first wrote the suggestions. Their suggestions included:

- Discuss students' learning style with them; help them to understand why they do what they do in learning situations;
- Be aware of students' background knowledge and experiences;
- Be aware of the pacing of activities within a time framework which may be rigid and inflexible;
- Be aware of how questions are asked; think about the discussion style of your students;
- Remember that some students do not like to be spotlighted in front of a group;
- Provide time for practice before performance is expected; let children "save face," but communicate that it is okay to make mistakes;
- Be aware of proximity differences; how close is comfortable?
- Organize the classroom to meet the interactional needs of students; provide activities which encourage both independence and cooperation;
- Provide feedback that is immediate and consistent; give praise that is specific.

Additionally, as Hankes' (1998, 2005, 2007) research has demonstrated, while the starting point of Deyhle and Swisher's observations were what seemed effective with Native American students, their findings often also seem applicable to non-Native students as well. Boognl (2006) found that, in a classroom having a diverse student population, (1) inquiry-based learning of functions invited creativity and inventiveness which far surpassed the traditional learning process and (2) this approach to learning meshed well with the learning preferences of Native American students. Thus, while it is hazardous to assume that what works for the majority works equally well for Native American students; a participant was not far off at the Project PRIME Think Tank Event in May 2007 who exclaimed, "If we get it right for American Indian students, we will get it right for everyone."

Investigations in Number, Data, and Space

Investigations in Number, Data, and Space is a K-5 mathematics curriculum, developed by TERC (Technology Education Research Center), an organization that has engaged in extensive work in developing culturally-responsive curricula for Haitian-Americans (e.g., Conant, Rosebery, Warren, & Hudicourt-Barnes, 2001). *Investigations* has been funded by the National Science Foundation (NSF), and published by Pearson-Scott Foresman. An inquiry-based curriculum, it is designed to help all children understand fundamental ideas of number and operations, geometry, data, measurement and early algebra (retrieved from http://investigations.terc.edu/index.cfm).

The development of *Investigations* was informed by an extensive body of research on the teaching and learning of mathematics. The curriculum was influenced by national publications such as *Principles and Standards of School Mathematics* (NCTM, 2000), *Adding It Up: Helping Children Learn Mathematics* (National Research Council, 2001), and *The Mathematical Education of Teachers* (Conference Board of the Mathematical Sciences, 2002), and by research on students' understanding of number and operations (retrieved from http://investigations.terc.edu/index.cfm), such as the work by Deborah Ball, and Thomas Carpenter and colleagues. Like the earlier examples that were explicitly developed for working with Native American students, the *Investigations* curriculum highlights the student-centered approach, and imbeds cultural responsiveness into implementation by building from students' personal and thus culturally-mediated experience.

All of this is to establish that through Project PRIME and the adoption of the *Investigations* curriculum, RCAS established a base that could be explicitly responsive to Native American learning styles through the use of cognitively-guided instruction. Of course, the rub was whether what was designed and what was possible matched what transpired.

Policy as Blueprint versus Policy as Practiced

The "official curriculum" (Posner, 2003) i.e. what per design students and teachers are supposed to know and do - gives teachers a foundation for planning lessons and evaluating students. With Project PRIME and *Investigations*, RCAS elementary teachers are supported by the mathematics teacher leaders who provide assistance and suggestions for teachers as they alter their practice to inquiry-based mathematics. Rochelle Gutierrez, a prominent Latina education researcher with interests in equity in mathematics education, stated, "the goal is not to replace traditional mathematics with a predefined 'culturally relevant mathematics' in an essentialist way, but rather to strike a balance between opportunities to reflect on oneself and others as part of the mathematics learning experience" (2008, p. 2). Indeed the larger point of culturally relevant inquiry-oriented instruction is that the particulars of what constitutes culturally relevant will vary within groups, among groups, and over time, but that being culturally relevant will strengthen instruction.

Project PRIME has been a K-12 initiative that began with encouragement to adopt inquiry-based mathematics at the elementary level. Through Project PRIME the RCAS middle school math curriculum changed to *MathScapes*, a middle school inquiry-based mathematics program. For both of these tiers of Project PRIME, teacher leaders have been hired (grant-funded) to assist teachers in transition from traditional mathematics teaching to inquiry-based mathematics.

When I began teaching at BHSU in fall 2006 (I further consider my autobiography in Chapter 3 on Methodology), the Project PRIME-induced implementation of inquiry-based mathematics had just begun at the high school level. The previous secondary mathematics curriculum coordinator had retired and a new coordinator was hired during summer 2006. For high school, RCAS adopted *College Preparatory Mathematics* (CPM) which is advertised by its website (www.cpm.org) as a "complete and balanced curriculum for grades 6-12."

The teachers with whom I was in direct contact (through the newly-developed BHSU MSCI K-12 mathematics specialist degree) expressed only favorable comments about CPM. Some mentioned that using the curriculum strengthened their mathematical understanding and that their students' understanding seemed stronger than with a traditional mathematics curriculum.

The downside to this commentary is that this group of teachers may have represented the minority for the RCAS secondary math department. Secondary teachers, particularly in mathematics are often resistant to make any changes in their teaching style, regardless of what other teachers suggest or what the district mandates. If a teacher (at any level) strongly believes in his/her efficacy and students' test scores are acceptable, why is there a need to change? On a positive note, since Project PRIME began (seven years ago) many teachers at all levels who were resistant to this change have retired.

Levinson and Sutton (2001) stated, an original policy, including its core elements of a problem diagnosis and a proposed response is the starting template on which subsequent acts of interpretation begin. My point in mentioning Project PRIME implementation at each of these levels is to w juxtapose the Project PRIME initiative with what the original grant intended with what has been practiced (Levinson & Sutton, 2001).

III. Research Methods

An Ethnographic Case Study Approach

Because finding a link between policy and outcomes requires looking at what was actually done, as compared to just what was intended (Erickson & Gutierrez, 2002; Levinson & Sutton, 2001), an ethnographic case study approach (similar to Lipka, et al. 2005) was used to observe how select teachers made sense of enacted Project PRIME. That is, how did these teachers consider students' thinking and academic (mathematics) capabilities in the context of elementary classroom culture? The task of this chapter is to explain the multiple complementary research strategies (i.e., observations, participant observation, interviews, surveys, and document review) that together encompass an ethnographic case study and that helped me to understand Project PRIME implementation in RCAS and its prospective implications for the math achievement of Native American students.

Ethnography, literally the writing about groups of people, is a form of mainly qualitative research commonly used by anthropologists. Applying ethnography generally entails: using ethnographic methods to collect data (not just relying on interviews but drawing on observational data and cultural artifacts); a long term-commitment to the research site; adopting a stance of *cultural relativism* (an anthropological approach which posit that all cultures are of equal value and need to be studies from a neutral point of view);[1] taking the native's perspectives; and using holism in the collection and analysis of data (Muncey & McQuillen, 1996, p. 297). Ethnographic case study has been viably pursued by other researchers (e.g., Hamann, 2003; Muncey & McQuillen, 1996) and, like traditional ethnography it lends itself to using multiple particular data collection and analysis strategies as long as they shed light onto the larger research questions (Erickson, 1987). The key difference between classic ethnography and the hybrid ethnographic case study seems to be the latter's move away from the focus on a 'people,' to the case study's focus on a particular context and activity.

For purposes of better understanding Project PRIME implementation and more particularly the ways teachers thought about and acted in relation to the charge to reduce achievement gaps, I used an ethnographic case study approach to examine the types of discourse present in elementary math classrooms and how the discourse affected the classroom culture.

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[1] Wolcott's point (1988) that research is intrinsically interested – automatically the researcher has decided that this research question is more important than another one – does not undercut this recommendation to try to step back and avoid judgment.

Culture here refers to the beliefs, values, and attitudes that structure behavioral patterns of a specific group of people (Merriam, 1998), although it includes the now-rather mainstream anthropological understanding that beliefs, values, and attitudes are not static and depend on cultural activity (i.e., daily life) for both their reproduction and adaptation.

Schools embody a set of norms and values (Posner, 2003), some of which may be obscured or unofficial, but no less salient for that fact. A "hidden curriculum," which usually is not acknowledged by school administration, may have a deep impact on classroom culture. Giroux and Purpel (1983, as cited in Posner, 2003, p. 13) state that the messages of a hidden curriculum, which can incorporate understandings of class, race, and authority, teach children about "appropriate" behavior for students. This "appropriate" behavior subliminally addresses which children can succeed at various kinds of tasks, who have the right to make decisions for whom, and what kinds of knowledge are considered legitimate. In my ethnographic case study, I tried to identify what "hidden curriculum" was present in the classrooms I observe. If those classrooms proved to be student-centered classrooms that would nullify or diminish some of the predictable hazards that disproportionately affect some students (i.e., the hidden curriculum) that may be present in a math classroom with a more traditional approach to mathematics.

Fetterman (1998, p. 20) asserted that documenting multiple perspectives of reality in a given study is crucial in understanding why people think and act in the particular ways that they do. Ethnography lends itself to accomplishing this task in an elementary classroom while the teacher and students interact within the environment.

Ethnography is also well suited for studying educational change because of its holistic orientation. Systemic connections exist among myriad aspects of school life (Muncey & McQuillen, 1996, p. 16). An ethnographic perspective helps the researcher see how changes attempted in one facet of schooling influence other areas of school life (Muncey & McQuillen, 1996). Ethnography represents both a process and a product (Agar, 1980).

Smith (1992) suggested two possible strains of qualitative research in education: educationist and anthropological. The educationist treats schooling as a technocratic enterprise which focuses on various relata that are assumed to account for differences in learning outcomes. In contrast, the anthropologist views the enterprise primarily as webs of human relationships and is concerned with understanding what is going on from participant perspectives and what it means to them (pp. 195-196). I adhere here to Smith's anthropological view of qualitative research as I empathize with whom I observe and look to say how situations (if needed) can be improved.

As part of his presidential address to the Council on Anthropology and Education, Smith proposed a foundation of ten principles of ethnographic research that I tried to heed as I conducted this study, as they are central and significant to anyone conducting ethnographic research, but they are equally valuable as principles to live by (Gilmore & McDermott, 2006, p.206). However, perhaps related to my unavoidable role as an educationist in the field site (i.e. a professor of math education from BHSU and also someone who has spent more than half of my life identifying as a teacher), I must deviate from Smith's first principle as I do have a pre-conceived notion (informed by graduate training in mathematics education and 20+ years as a math teacher who implemented reform methods of teaching mathematics) that cognitively guided instruction and Project

PRIME were appropriate for RCAS elementary teachers mathematics and would help improve the attitude and achievement of Native American students in adequately implemented.

Smith recommended:

1. Start with no preconceived notions about what's happening and what this means to participants.
2. Let the important questions be addressed, as well as the answer, emerge from the context. If a researcher encourages participants to tell their own stories, the researcher will be confronted with questions she might not have thought to ask.
3. Do not view participants as subjects but as co-learners with the investigator, each using the other to reach shared and ever-deepening understandings.
4. Take seriously the uniqueness of each setting and set of events.
5. Take as primary importance relationships rather than relata. Interpretive research recognizes that things, however defined, are never as important as the ways they are related to each other.
6. Assume that people inevitably act to make sense of the world they are experiencing.
7. Assume that patterned behavior reflects the presence of underlying power relations.
8. Recognize that genuine understanding can only come through genuine participant observation.
9. Ultimately the power to solve their problems, or even to determine what they are, rests with the participants in an activity.
10. Change takes place when we hear another "story," it resonates with our own experience, and we feel free to take from it for our particular uses. Few real life decisions are based on statistical generalizations…as researchers we should seek our task as that of recovering and presenting in authentic and

> credible form the individual stories we have gained access to. (1992, pp. 204-205)

I took Smith's second and sixth principle in particular as reminders that Project PRIME as understood and purposefully pursued by RCAS elementary teachers may well be different from what I think it should be and what a formal description of it looks like. If my larger goal is to understand if CGI and Project PRIME in particular were good tools for improving mathematics education for elementary American Indian students and if I further understand that for this to be so, instruction would have to have been culturally relevant and responsive, then I need to be very clear on how the curriculum was understood and enacted by those who attempted to use it. In this sense, the "official" or 'on paper' version of Project PRIME was less salient than the "implemented" version, although clearly the latter was substantively informed by the former. RCAS proved to be a particularly informative site because it showed on-the-ground curricular adaptations that made inquiry-based instruction inquiry-based and culturally responsive. Furthermore, I was interested in the interactions between the teachers I planned to study and their students. Teachers who respect cultural differences are more apt to believe that students from non-dominant groups are capable learners, even when these children enter school with ways of thinking, talking, and behaving that differ from the dominant culture (Delpit, 1995).

Stake (1995) described case study as "the study of the particularity and complexity of a single case, coming to understand its activity within important circumstances" (p. xi). Case study is appropriate for my situation as I wanted to study the particularity and complexity of teachers who are implementing inquiry-based mathematics at schools with a significant minority and diverse socioeconomic population. Merriam (1998) verifies that one or more cases can be studied within a bounded system; a case study that includes more than one case is known as a *collective case study* (Stake, 1995). "Each case study is instrumental to [the purpose of the overall study]…and there will be important coordination between the individual studies" (pp. 3-4). Thus, in studying Project PRIME's implementation in the four chosen elementary schools, I studied four teachers as part of a collective case study. I looked to learn about variations and similarities between the teachers in the degree of inquiry-based mathematics implementation along with their relationship with and understanding of their minority students. Using four cases allowed for their varying ontologies to emerge and be compared. I included examples of students' work in Chapter IV to show the various strategies used by students to solve a problem. With inquiry-based mathematics, there is not "one right way" to solve a problem and different solution strategies are encouraged.

The Elementary School Sites

Before I describe the four teachers and their classrooms that were studied, I provide information about the schools where the teachers work: Lincoln, Washington, Roosevelt, and Jefferson. I realized that selecting multiple cases increased the amount of necessary data and reduced the attention that I could pay to one case. However, I sought to find more about how teachers make sense of inquiry-based mathematics and the task of using it to, among other things assure their American Indian students succeed. The variance and similarities found among the four teachers with their learners in a collective case study better assisted me in investigating my research agenda.

Lincoln (a pseudonym) was a K-5 elementary school located in an older, mostly low-income section Rapid City which enrolled 565 students. Fifty-five percent of the student population was Native American and thirty-nine percent was white; seventeen percent receive special education services and seventy-five percent of the students qualified for free-and-reduced lunch. The school was classified as a school-wide Title I school and claimed zero percent homeless migrant students. Three elementary math teacher leaders worked at Lincoln to promote inquiry-based mathematics within the school. I call the Lincoln teacher (introduced later) whose work I looked at most closely, "Hannah."

Jefferson (another pseudonym) was a K-5 elementary school with 270 students. Forty-seven percent of the students were Native American and forty-six percent were white. Seventy-one percent were classified as economically disadvantaged and qualified for free and reduced lunch, and seventeen percent of the students were classified as "homeless migrant" meaning they may not live with parents, but rather, grandparents, or aunts and uncles. One elementary math teacher leader was responsible for assisting the K-5 teachers with inquiry-based mathematics. I call the Jefferson teacher (introduced later) whose work I looked at most closely, "Emma."

Washington (another pseudonym) was a pre-K-5 elementary school located in central Rapid City that served 413 students, 58 of whom were enrolled in preschool. Sixty-three percent of the students were Native American while twenty-seven percent were white. Thirteen percent of the students receive special education services while eighty-six percent were classified as economically disadvantaged. Less than one percent was classified as gifted, and less than one-percent was limited-English-proficient (LEP).

Seventeen percent of the student population was classified as "homeless migrant." I call the Washington teacher (introduced later) whose work I looked at most closely, "Martin."

Although Washington is an old school, when I visited, it had just moved into a new building (that was constructed at the same time as an adjoining public library). Two elementary math teacher leaders served the K-5 teachers at Washington. The two math teacher leaders were involved with Project PRIME since the onset of the grant, although 2007-2008 was the first year at Washington for one of the teacher leaders.

Roosevelt (another pseudonym) was a K-5 school in the south-central area of Rapid City. There were 400 students enrolled of whom 24% were Native American; fifty-six percent of the student population were classified as economically disadvantaged. The other statistics mentioned for the other elementary schools (e.g., 'homeless migrant enrollment') are not mentioned with Roosevelt because the percentages were small. One elementary math teacher leader served the teachers at Roosevelt elementary. I call the Roosevelt teacher (introduced later) whose work I looked at most closely, "Madison."

Participant Selection

The selection of the cases for my ethnographic study came from within a bounded system since the four teachers examined were fifth grade classroom teachers in the RCAS school system. Three of the teachers taught at schools where the Native American student population was greater than fifty percent, while the fourth teacher taught at a school with a smaller (24%), but still substantial Native American population. Moreover, the fourth school was noted by the district and Project PRIME management as an exemplary implementer of inquiry-based mathematics. I chose to observe fifth grade classrooms for two reasons: the majority of the fifth grade students (those who lived in Rapid City for most of their lives) have supposedly been involved with inquiry-based mathematics for their entire elementary school career (i.e., it has been the official curriculum for the bulk of their schooling). Secondly a former student of mine, Martin Red Bear, taught fifth grade at Washington. (It is much more common in qualitative research to leave research participants unnamed and anonymous and I do so for the three other focal teachers, but I have opted not to do so with Red Bear (a) because doing so would require obscuring a salient relationship from readers, (b) I have Mr. Red Bear's consent to do so, and (c) this is one means to highlight my historic and ongoing relationship with Project PRIME, RCAS, and BHSU.

Not only was I interested in the amount of inquiry-based mathematics implementation, but also remembering Lipka (2005), I wanted to see if there was a noticeable difference in the interactions between Martin Red Bear and his Native American students versus what he did with other students. My existing status with Martin helped me gain insider status and thus access to more detailed, private, and credible information about how Project PRIME is being received and implemented within the four Rapid City elementary schools that I investigated. Given that I had a lead to look at one fifth-grade teacher; it made sense to look at other fifth-grade teachers (who also serve a significant Native American enrollment). This reduced the likelihood that variations in how participants engage in Project PRIME are a product of different grade level expectations of that project. An unexpected result of narrowing my selection pool to fifth grade was observing teachers who had enrolled in few courses offered through Project PRIME; however all followed the guidance provided by their teacher leaders who all had taken several Project PRIME math courses. The four teachers selected for observation were encouraged by their teacher leaders or principal to help in my dissertation efforts. All four teachers were relatively new to the fifth-grade classroom and two of the teachers *had* taken mathematics professional development courses offered through the Project PRIME grant at the time of observation. This may appear as a less-than-representative group for the effectiveness of Project PRIME; however, the four were willing participants at the representative schools. Not all teachers are comfortable with the thought of being "observed" for educational research purposes. Excepting Martin Red Bear, the names of the other individuals and schools are pseudonyms.

Classroom Observations

I observed the four 5th grade classrooms during the fall 2008 semester. I initially intended to observe the teachers implement the study of division strategies that are presented in the 5th grade *Investigations* text, but the four teachers were not at the same place in their textbook. I originally planned to use the Oregon Mathematics Leadership Institute (OMLI) Classroom Observation Protocol Instrument to classify and document the various types of discourse (instrument available at http://hub.mspnet.org/media/data/OMLIClassroomObservationProtocols.pdf?media_000000001413.pdf). However, once I began observation, I set the OMLI protocol aside. I realized I was able to record the information and the type of discourse narratively and that by not using the protocol I could also record other details of setting and action that appeared salient to my research question. Secondly, the OMLI protocol became less important because I observed each teacher only four times and so the precision the OMLI protocol offers became less important as I was less dependent on having a 'definitive' framing of just one individual. Lastly, many of the evaluative statements to be completed by the observer in the OMLI protocol were duplicates of the statements included in my online survey.

I had included in my IRB that I would videotape my observations to help with my note-taking. Once I began my fieldwork I realized that the video camera was an additional distraction for the students. I was unable to set the camera up before students entered the classroom (where they stayed in for the entire day) since I had to come down to Rapid City from Spearfish during the morning after teaching class. After one attempt of setting up the camera and recognizing the distraction and amount of refocusing it caused for the teacher and students, I chose to forgo videotaping. Although most ethnographic methods are interactive since they involve people, ethnographers should be as unobtrusive as possible to minimize the effect on participants' behavior (Fetterman, 1998, p. 57).

After my observations I used the "Levels of Engagement with Children's Mathematical Thinking" developed by Franke, Carpenter, Levi, and Fennema (2001, p. 662) suggested to me by Judith Hankes to evaluate teacher beliefs and values with the presented lessons. The "Levels of Engagement" portrayed by each teacher was a result of their collaboration with their respective school's teacher leaders for Project PRIME. (See Appendix B)

I used this instrument to code the levels of student-student and teacher-student engagement by reading holistically the observation field notes and the teacher interviews, searching for evidence that supported each benchmark. Additionally I looked for evidence that indicated a teacher had not reached a particular benchmark and cited specific instances from the data. I realized that four observations were not adequate to make a steadfast judgment of an individual teacher and, perhaps surprisingly, that too is part of my research design. Given my other responsibilities (as a teacher educator) and professional desire for an ongoing relationship with RCAS I do not want to be in a position where my studies can be used as ‘proof’ related to the performance of an individual teacher. Rather, what I have tried to do here, through sixteen observations of four teachers in four settings, complemented by a survey given to 37 RCAS teachers (which helps situate these four), is to portray when, how, and if I saw evidence of inquiry-based methods. That, in turn, sets up consideration of whether a pedagogical strategy that should be more responsive to Native American students than traditional methods, is at all commonplace and purposefully deployed.

Elementary Math Teacher Leader and Elementary Math Coordinator Interviews

Once I began to observe the four elementary teachers’ classrooms, I learned more about the math game homework given at Roosevelt, and reflected upon the four classroom teacher interviews, I realized the role of the teacher leaders in promoting a culture of critical colleagueship (Lord, 1994) that could enhance teacher collaboration and classroom performance. As a consequence, I made a change to my initial IRB proposal so I could interview the elementary math teacher leaders that worked at the four elementary schools and also the current elementary mathematics coordinator. A substantial body of research exists on the range of benefits critical colleagueship for teachers, such as greater openness regarding classroom practice, reciprocity in sharing knowledge, collective planning and design of curriculum. The teacher leader interviews provided me with further insight on *Investigations* implementation, Project PRIME implementation, and whether the math game folders could play a role in the difference in student achievement between Jefferson, Washington, Lincoln, and the supposedly highly successful Roosevelt elementary.

I assured the math teacher leaders that the information they provided me would not be differentiated so that readers would not determine where they taught and who they were. I guaranteed that the information would be presented so that anonymity would be preserved.

I interviewed all three teacher leaders (K-1, 2-3, 4-5) from Lincoln, the teacher leader from Jefferson, and the teacher leader from Roosevelt. I interviewed the teacher leader who worked with 3-5 at Washington; the K-2 teacher leader was ill on the day of our rescheduled interview.

Teacher Survey Variables and Measures

I developed a survey instrument to obtain information from all K-5 teachers at the four elementary school sites. My survey was intended to help triangulate my data (along with classroom observations and teacher/teacher leader interviews) and situate the four focal teachers as typical of range of experience and orientations in RCAS. The key variables of the survey were teachers' efficacy and beliefs about teaching with inquiry-based mathematics, along with teachers' attitudes and beliefs about culturally responsive teaching in mathematics. An invitation to participate in the voluntary survey (n = 70) was given to the elementary teachers at Washington, Jefferson, Lincoln, and Roosevelt schools and answered by 54% (n = 38).

I looked to Horizon Research, Inc. for part of my survey questions on inquiry-based mathematics. Horizon Research develops and evaluates survey data for the National Science Foundation. I received permission on June 1, 2008 from Joan Pasley of

Horizon-Research to use parts of their Local Systemic Change teacher survey. Judith Hankes from the University of Wisconsin-Oshkosh provided me with teacher belief questions that centered on cognitively guided instruction. Survey questions 1-6 addressed teacher demographic information Arrays 7 and 8 contained questions on teacher beliefs and preparedness; while arrays 9 and 10 contained questions that pertained to teacher knowledge and beliefs. Arrays 11 and 12 had questions that involved teacher beliefs and preparedness. Questions 13-17 involved mathematical instructional practices and routines while 18-25 addressed classroom demographic information.

My survey included four questions that addressed culture and culturally responsive teaching practices. The Rapid City Area Schools (RCAS) website (www.rcas.org) has a link for American Indian education Title VII resources: http://www1.rcas.org/indianed/ie_index.htm . The website includes links to Lakota history and culturally responsive teaching. I included questions to determine whether RCAS elementary teachers were familiar with and/or had used any of these resources.

In July, 2008 I contacted Rick Bates[2], the RCAS information technology liaison, to obtain email addresses of the Jefferson, Washington, Lincoln, and Roosevelt personnel. In September 2008 I emailed a letter to 70 K-5 elementary teachers, elementary teacher leaders, and special education personnel at the four schools to voluntarily participate in my online survey located on SurveyMonkey.com.

My email indicated that the online survey would be available until October 31, 2008. The majority of the survey respondents did so within the first week that the survey

[2] The name is not a pseudonym, it is acceptable to use his name (a) because he is not a direct source of data (but rather a conduit for them) and (b) because, per Erickson (1984), it allows readers to figure out how they could hypothetically, redo the study and decide whether they would draw the same conclusion.

was available. I sent out a second email reminder about completing the survey; I gave $2.00 Coffee gift certificate to those who completed the survey. By the deadline, 54% (38/70) of the teachers responded to the survey.

Merriam (1998) lists six basic strategies to enhance internal validity of qualitative research: triangulation, member checks, long-term observation, peer examination, participatory or collaborative forms of research, and researcher's biases. For my research I utilized data triangulation, member checking, and I was aware of my researcher bias. Field notes, interviews, logs from protocol implementation and survey results were used to triangulate my data. I shared the interview transcripts with the observed teachers, the math teacher leaders, and the elementary mathematics curriculum coordinator so they could clarify any areas where misinterpretations could have occurred.

Preventing Researcher Bias

I kept a journal to regularly take a mental step back from my work to examine it with a critical lens, including considering possible ways I might be biased. As I recorded in my journal several times, it was difficult to paint value free descriptions and interpretations. "Phenomena need accurate description, but even observation interpretation of those phenomena will be shaped by the mood, the experience, and the intention of the researcher. Some of these wrappings can be shucked, but some cannot" (Stake, 1995, p. 95). An obstacle not mentioned by Stake was the number of classroom observations; sixteen observations is a plentiful number but when divided amongst four teachers, it is difficult to make any type of summation about the teachers, beyond important but general claims like, that all four were competent, enthusiastic, and cared for the well-being and achievement of their students.

With my previous, smaller scale research activities and my work for BHSU, I have developed collegial relationships with my some of my subjects. I admit to a subject researcher's perspective and have accepted involvement and bias as inevitable as a participant observer. This interestedness means I need to position readers to account for my likely biases and to correct them, but it also means I have been positioned to build relationships with the Rapid City elementary schools teachers that I work with. As Toma (2000) stated, getting close to my subjects makes my qualitative data better, as it makes it likelier that participants shared with me what they are thinking rather than what they think I want to hear.

IV. Project PRIME as Culturally-Responsive Cognitively Guided Instruction

Project PRIME History

Project PRIME has been a targeted Math Science Partnership (MSP) that focused on K-12 mathematics within the RCAS district. It began with National Science Foundation funding in 2002. An initial objective of Project PRIME was to decrease the mathematics achievement gap between white and non-white students by introducing inquiry-oriented instructional materials in the K-12 mathematics classroom.

Project PRIME has been a partnership between BHSU (Black Hills State University), RCAS (Rapid City Area Schools), and TIE (Technology and Innovations in Education, a division of the Black Hills Special Services Cooperative). Through a collaborative, multi-faceted curriculum implementation and professional development model, all RCAS teachers of mathematics were eligible to receive at least 100 hours of professional development in a combination of content-based workshops delivered primarily through district level and building-based activities that focused on modeling effective lessons, peer mentoring, coaching, and lesson study. Elementary mathematics teacher leaders were eventually assigned to every school in the district, and they provided job-embedded professional development and support at the classroom level. (retrieved 1/06/2009 from http://www.primeproject.org/default.htm).

The goals of Project PRIME were to improve student achievement in mathematics for all pre-K-12 students in the Rapid City School District, and increase and sustain the quality of pre-K-12 teachers of mathematics in the Rapid City School District over time. Following the "goal, objective, and initiative" hierarchy, the objectives of Project PRIME were to raise the mathematics achievement of all pre-K-12 students in the Rapid City School District according to criteria established by the state of South Dakota Department of Education. One initiative of the Project PRIME was to reduce the achievement gap between Native American and non-native students in RCAS (retrieved 1/06/2009 from http://www.primeproject.org/management/default.htm). In turn, that initiative became the leaping off point for this dissertation.

In terms of initial implementation of Project PRIME, the first task of the leadership team was to hire nine elementary math teacher leaders by the end of January, 2003. These leaders were to assist the teachers who chose to implement *Investigations* in their classrooms (later in this chapter I detail how *Investigations* and another curriculum were rather haphazardly selected as RCAS elementary math curricula). In that same month, weekly professional development sessions were initiated by the RCAS elementary math coordinator and a BHSU mathematics education professor for the elementary math teacher leaders.

By fall 2003, the RCAS elementary math teacher leaders and the RCAS elementary math coordinator were providing building-level professional development sessions. The previous summer, the courses *Mathematical Thinking through Investigations in the Elementary Classroom Grades K-2* and *Mathematical Thinking through Investigations in the Elementary Classroom Grades 3-5* were offered to Rapid City elementary teachers. The teachers were not "required" to attend the training, yet the attractiveness of the NSF-provided stipend for successful completion of courses helped persuade several RCAS teachers.

On January 22-24th, 2004, the elementary math teacher leaders received Cognitively Guided Instruction (CGI) training from personnel from the University of Wisconsin-Madison. This was the first intervention that specifically addressed the Native American/non-native achievement gap (Austin, 2006). Later that year (July 2004), two teacher leaders and June Apaza received advanced CGI training in Madison, WI. The two teacher leaders, June Apaza, and Ben Sayler took the lead in offering courses in CGI for the Project PRIME grant. Their courses were called *Cognitively-Guided Instruction I* and *Cognitively-Guided Instruction II*. Later, once the impetus to develop a South Dakota K-12 mathematics specialist endorsement began in 2006, the names were changed to "Understanding Student Thinking in Numbers and Operations" and "Understanding Student Thinking in Algebra."

In spring and summer 2004, a BHSU education colleague and the RCAS elementary math coordinator offered classes on *Using Investigations to Promote Inquiry-Based Mathematics in K-5* for RCAS teachers. On July 30th-August 4th, 2004 a Teacher Leadership Institute on *Investigations* was provided by TERC. Additionally, beginning in the summer 2004, a course called *Foundations of Effective Mathematical Practices* which focused on inquiry-based mathematics was offered to RCAS teachers through Project PRIME.

Stipends that teachers would receive after successfully completing a course were incentives for teachers to enroll in the professional development courses (I make this claim after personal conversations about it with RCAS faculty, and based on my personal experience with similar grants – e.g., Nebraska Math Scholars, Math in the Middle). The courses were structured for thirty content hours and teachers received $20 per hour, thus they each received $600 at the conclusion of a course. Graduate credit was available through BHSU at the course recording fee. At the beginning of the project, Project PRIME-related classes were offered for $55.85/credit hour; in 2008 the classes were offered at $43.20/credit hour. Once the grant money is no longer available (i.e., sometime after this writing) the courses will cost around $241/credit hour (depending on what the South Dakota Regents set as the rate for graduate credit). The courses have been taught by the RCAS elementary mathematics coordinator, trained RCAS teachers, and BHSU/CAMSE personnel (including since 2006, me).

An Achievement Profile of the Four Elementary Sites

Appendix D contains Dakota-STEP achievement score data displayed in tables and graphs for the four elementary schools examined in this study. The information was retrieved from the South Dakota Department of Education "No Child Left Behind" website (http://doe.sd.gov/nclb/).

The data and graphs provide evidence that the achievement gap between Native American students and Caucasians has been reduced; however, a substantial gap still exists. Moreover the variability in the gap is a reminder that one-year improvements may just be epiphenomenal (a product of a different batch of students taking that year's tests, rather than any changes in instruction or learning). Each table shows the achievement gap for proficient or above, and also the small achievement gap that exists between the basic achievement scores for Native American versus Anglo students.

The achievement gap at Washington grew from 2003 to2006, but in 2008, there was only a 1% gap. In 2007, the Native American population scored 11% higher than the Caucasian population. The numbers were encouraging. I included the Basic achievement data along with Proficient to show that the basic achievement gap was also minor. (See Appendix D: Table 1/Graph 1)

Similar to the Washington data, the achievement gap at Jefferson increased from 2003 to 2007, but then decreased in 2008. The 2008 10% achievement gap is highly encouraging. (See Appendix D:Table 2/Graph 2) The achievement gap at Lincoln has been sporadic; however, it is worth noting that Lincoln made AYP in 2008 and the school climate and attitude data indicate that achievement will continue to improve. (See Appendix D:Table 3/Graph 3)

For three of the academic years during 2003-2008, the Native American population did not meet the minimum population size requirements at Roosevelt to be counted for NCLB-related achievement outcomes, which impedes comparison. To help fill in those gaps, the Roosevelt principal tried to give me the data from where he had submitted it to the South Dakota Department of Education, but the data were not retrievable. That said, both Roosevelt's principal and elementary teacher leader indicated that the Native American achievement had significantly improved since the beginning of Project PRIME**.** (See Appendix D:Table 4/Graph 4)

The achievement scores for both the Caucasian and Native American populations have increased since 2003, the start of Project PRIME and the implementation of Investigations in the RCAS elementary schools. The data show that an achievement gap exists but that scores for both groups have increased over the five-year span. (See Appendix D: Table 5/Graph 5)

A graph of statewide data suggests that the Native American achievement gap has decreased statewide. This complicates crediting *Investigations* and Project PRIME (or inquiry-based mathematics more generally) as the reason for RCAS improvement, as an alternative explanation could be broached that RCAS' improvement instead comes from the same (unspecified) factors that are leading to improved Native American outcomes elsewhere in South Dakota. I recently learned (although I may have been told earlier) that the Dakota-STEP was revised in 2006 (See Appendix D: Table 6/Graph 6). One partial way to get past this conundrum is to look at what was actually happening in RCAS classrooms, as the next segment does.

Now that a brief history of the Prime PROJECT has been given, and Dakota-STEP achievement data, I focus upon the impact the grant has made on mathematics teaching in schools that serve a significant Native American population. Although the observed teachers had little experience with Project PRIME courses directly, the mannerisms were present in the teachers' classrooms that are associated with inquiry-based mathematics.

HANNAH

Hannah lived most of her life on the East Coast. She received her undergraduate education in sociology and worked in the health care field for seventeen years. More than fifteen years prior to my observation of her she earned a master's degree and teaching certificate concurrently.

Hannah taught at Lincoln since moving to Rapid City. She was a fifth grade literacy teacher for six years prior and she was in her second year as a fifth-grade classroom teacher at the time of my observation and interview.

When I first observed Hannah's classroom, her desks were in rows which is normally associated with a traditional classroom. She was quick to note that the desks had been in groups at the beginning of the year, but the students needed some "alone" time to work on mathematics. After Hannah's initial introduction to the lesson of the day, students were allowed to move about the room, find a partner and a different area to work than their assigned seats. When I made my last observation in November, 2008, the desks had been moved back into groups.

Hannah's classroom housed 30 students: 15 boys and 15 girls. Her classroom racial demographics were atypical for Lincoln with 16 Native American students and 14 Caucasian students. The student mix varied with each row; however she had one row of all female students. (See Appendix C: Diagram 1) She had a Native American Title VII aide who monitored and assisted students as they were working. The Title VII aide also worked in the teacher leader/math recovery room.

At first I was surprised to see the desks arranged in rows in Hannah's classroom. A row and column arrangement is characteristic of a traditional classroom. During our initial meeting Hannah indicated that her desks had been clustered into groups but the students' productiveness had degenerated. She made a decision to put them back in a traditional setting, but by the time my observations concluded, her desks were arranged in back in a manner conducive to inquiry-based learning.

Hannah's row and column arrangement was used at the beginning of class when whole-class instruction and discussion took place. When students worked in groups (which they did during all of my observations), the students were allowed to find a place in the room that was comfortable for them to work.

At the time of observation, Hannah had not participated in Project PRIME math courses, as she was only in her second year as an RCAS classroom teacher. However, she enrolled in ED 601 Foundations and Issues in Mathematics Education in the spring 2009 semester which I instructed.

EMMA

Emma is a native South Dakotan who lived in various towns across the state while growing up. She attended a South Dakota university for her undergraduate degree in elementary teaching. She is currently working on her Master's Degree in literacy through the University of Sioux Falls. The University of Sioux Falls is a private institution, thus I was surprised that she chose to earn her Masters degree in literacy, rather than pursing her Master's of Science in Curriculum and Instruction (MSCI) degree with an emphasis on K-12 math education from BHSU. Due to grant funding that began with Project PRIME, teachers enrolled in the Project PRIME program pay only the "recording fee" rate which is currently $43.20 per credit hour. I recently learned that the University of

Sioux Falls recording fee is less than the BHSU recording fee and a teacher in Emma's school teaches the graduate literacy classes.

Emma is in her fourth year of teaching; she taught 7th grade science her first year as a teacher and then moved to Rapid City. She taught fourth grade at Emerson elementary (a pseudonym) the two years prior to arriving at Jefferson. She had resigned her position at Emerson to move across the state with her fiancé; then her fiancé's transfer fell through. Her position at Emerson had been filled; thus she filled a vacancy at Jefferson.

Emma's classroom housed 19 students: 9 boys and 10 girls. She had her desks arranged in a shape that somewhat resembled a division sign (÷) except with two dots above and below the horizontal bar (See Appendix C: Diagram 2). When I asked her about the arrangement, she indicated that it made it easier to move around her room quickly. The fact that the students sat closely to at least one other student is indicative of inquiry-based mathematics. When it was time to work with a partner, Emma allowed students to find a partner and a comfortable place to work similar to Hannah's instructions. Emma had taken ED 601 Foundations and Issues in Mathematics Education in spring 2007.

MADISON

Madison is a native South Dakotan and went to high school in a small town near Sioux Falls. She graduated in 2001 and went to a liberal arts college in Minnesota where she received her teaching degree. Madison was in her third year of teaching, all at Roosevelt and all at the fifth-grade level. Madison had taken couple of math classes offered through Project PRIME. She has acquired over thirty graduate education hours, but she had not decided what area to focus on to earn her master's degree.

Madison's room held 28 students: 14 boys and 14 girls. Her desks were in groups of two- and four tables (See Appendix C: Diagram 3) with six four-table arrangements, two two-table arrangements, and one lone desk. Her room seemed small, but her desk groupings intentionally made it easy to move about the room and indicative of an inquiry-based mathematics classroom. Madison kept the students' math binders at the back of the room near her desk.

MARTIN

Martin lived in the South Dakota-Nebraska area most of his life and has lived in Rapid City since 1995. Martin is half-Lakota and half-Pueblo. Martin's mother is a Santa Clara Pueblo, and his family lived two miles outside of Espanola, NM through his first grade school year. His mother speaks the Tewa language along with his grandparents, aunts, and uncles. However, Martin and his twin sister never learned the language.

Martin's family moved to Kyle, SD on the Pine Ridge reservation when he and his twin sister were in second grade. Martin's father is Lakota, and all of Martin's father's parents and siblings spoke the Lakota language. Martin and his sister never picked up enough Lakota to be considered "fluent" in the language, although they know more Lakota than Tewa.

Martin attended high school in Rushville, NE (where I was his math teacher) and received a Bachelor of Arts degree in history and American Indian studies from Chadron State College. Because of his Lakota heritage and easy-going personality, after college he was hired by RCAS as a Lakota cultural resource specialist who would come into classrooms and give presentations on the Lakota culture. Later, several people encouraged Martin to become a teacher; so he joined a cohort of students at Oglala Lakota Community College in a career ladder program where persons with an undergraduate degree could earn an elementary teaching degree. Since finishing his program, he has taught fifth grade at Washington for three years, and thoroughly enjoys teaching mathematics. He told me that math was his favorite subject to teach (and then smiled and clarified that he was not saying that because I was both his former 8th grade math and high school advanced algebra teacher).

Martin's classroom at Washington contained 28 5th grade students: 16 boys and 12 girls. Eighteen of Martin's students were Native American. Martin used tables in his classroom; three tables were arranged to form an upside-down T (See Appendix C: Diagram 4). Martin did not have a paraprofessional that was assigned directly to him; however, Mr. High Hawk (a pseudonym), with Native American heritage, would come in during his social studies and his math time and help tutor students. Another helper worked specifically with one or two students who were on Individual Education Plans (IEPs) for math.

Observation Findings

HANNAH

Although Hannah was only in her second year as a fifth-grade elementary classroom teacher and that she previously was a literacy teacher, I categorized her Levels of Engagement score (using the Levels of Engagement protocol (Franke, Carpenter, Levi, & Fennema, 2001) as a 4 (out of 5). She developed problems (to accompany the

Investigations lessons) for children to solve that were relevant to their personal experiences; the problems elicited their thinking and she provided them with freedom to choose how they were to arrive at a solution. In my four observations of her classroom, Hannah continually utilized *pedagogical content tools* (PCT) (Rasmussen & Marrongelle, 2006) while instructing students. A PCT is a device (based on Shulman's pedagogical content knowledge, 1986) such as a diagram, equation, or verbal statement that a teacher intentionally uses to connect to student thinking while moving the mathematical agenda forward (p. 389). The problem and discourse below is from my first classroom observation.

A problem Hannah had written on the white board and asked the children to solve was, "*You and your friend have made $14.00 at your lemonade stand and you want to donate some money equally to 4 animal shelters. How much would each shelter get?"* She followed this inquiry with the directive, *"You will work with a partner but both people need to write and solve the problem."*

Hannah reminded students that they could use manipulatives (tiles, graph paper, etc.) to help them solve the problem. Students immediately sprang into action and moved around the room to find the partner they wanted to work with. Once a partner was found, the pair moved to an area in the room that was comfortable for them to work. Students appeared familiar with this routine and found a partner to work with in a small amount of time. Some students pulled their desks together, others chose to work in open areas on the floor, while other move to the countertops available on the side of the room (See Appendix C: Diagram 1). One Native American student was allowed to work by himself. Hannah later commented that he preferred to solve problems on his own but would work cooperatively when necessary. I sat by him at the back table where he informed me that he liked math but sometimes thought it was boring.

The way in which student groups chose to solve the problem varied. For example, two girls near me used partitive division and dealt out the tiles. A girl took 14 tiles and counted out 4 tiles. She continued to "deal out" the tiles to each of the four groups. The girls saw that two tiles were left so that each animal shelter would get an additional half-tile. In a partitive division problem, students construct groups of objects. The solution to the problem requires the student to find the number of objects in the group rather than the number of groups (Carpenter et al., 1999).

I walked around the classroom to observe different division strategies; I stopped at one group and asked them to explain to me how they solved the problem. A boy explained to me, "I know 4×3=12 so I have 2 left. I have to divide $2 by 4." It took him awhile but he came up with fifty cents for each group.

The Native American boy working by himself chose graph paper to solve the problem. He drew out 14 squares on the graph paper and explained that if he divided 14 into 2 groups there would be 7 in each group, "But," he said, "There are four groups." (See Appendix E: Diagram 1)

A third group had written on their papers: $4 \times 3 = 12$, $4 \times .5 = 2$

$$12 + 2 = 14$$

Hannah directed her students back to their seats so they could share their strategies. The Promethean Board (an interactive white board) was used to share different students'strategies to their solution. She asked if anyone used the"hangman" strategy; several students raised their hands. As students began to present at the

Promethean Board, Hannah encouraged students to write down other students' strategies in their notebooks.

A student went to the Promethean Board and showed how his partner and he used the "hangman strategy" to solve the problem. (See Appendix E: Diagram 2)

Fifteen hands go in the air to show their strategies. Hannah asks two Native American girls to come show how they solved the problem. (See Appendix E: Diagram 3)

Another student asked the girls, "How did you know to use $0.50?" The other girl in the group responded, "Because we knew $2 = 200 ¢.

I noticed that the girls used squares to model the four different animal shelters. Carpenter and colleagues (1999) note that often time students represent the groups themselves with an object that is not a part of the group. Doing so allows the child to model the given number of groups before they begin to deal with the objects in the group (p. 38).

The Native American student who had worked alone went up to the Promethean Board and showed his strategy (See Appendix E: Diagram 1).

EMMA

I was able to observe Emma's classroom on consecutive days where students were working with division problems. Emma began the first class by writing 165÷15 = 11 on the Promethean Board. Next she asked students if they could name the parts of the division sentence. Three different boys correctly name the quotient, divisor, and dividend.

Emma asked the class, “Is there another way that we could write this problem?” One girl placed the divisor and a second placed the quotient for the result:

$$\text{divisor}\ \overset{\text{quotient}}{\overline{)165}}$$

Emma asked the class again, “Is there another way that we could write this problem?” A girl said $\frac{5}{15}$. Emma responded, “Oh you are so close! It is $\frac{165}{15}$.”

Emma told the class, “A fraction is a division problem. Please take a piece of white paper. Put your name on it so I can find it. Work one of the problems on the front and the other on the back.” Emma writes two division problems on the board: 168÷12 and 198÷18.

I walked around the classroom to observe students as they solved the problems. Some of the strategies I noticed were skip counting by 12s, trying to use a box strategy (trying to undo the multiplication by placing the numbers in the appropriate boxes – box strategy is used to multiply). But mostly I saw students using tally mark to solve the problem. (This is not very efficient.)

I observed the next day when Emma had written on white board: I went to the store and bought 220 folders and I need to split them up evenly between the 20 kids in the class. Emma then asked the class, “How would I write this (as a mathematical equation)?”

A Native American boy responded 220÷20. Emma asked the class, “How else could I do this?” Another Native American boy said $\frac{220}{20}$, and a girl responded $20\overline{)220}$.

Emma asked the class, “What would your divisor be?” The class unanimously responded

20. Emma asked the class, “What is the quotient?” A boy tells her 11 so Emma asked him how he found his result. The boy says, “I counted my 20s.” Another boy tells Emma that the dividend in the problem is 220.

Emma told the students to get out their notebooks and write the following problem in their notebook. Emma said, “There are 252 4th and 5th graders. They have to be put on 21 equal teams. How many people will be on a team?”

I walked around the room to observe the strategies that students used to solve the problem. One student had written: 252÷21

210÷21=10
<u>42÷21= 2</u>
252 12 There are 12 teams.

The student had used the “friendly number” 10 to help him solve the problem. (Numbers that end in 0 are considered friendly numbers)

A group of Native American girls wrote:

21 X _______ = 252
21 X 10 = 210
21 X 1 = 21
21 X 1 = 21

I asked one of the girls to explain to me what she did. She told me, “I wrote 21 X _____= 252.”

Emma asked her why she chose 10 and the girl said that she was not sure. (Ten was used because it is a friendly number) I later found out that the girl who wasn’t sure why she had used 10 had recently moved into the district and was unfamiliar with inquiry-based mathematics (and its emphasis on knowing not just what to do but why you are doing what you are doing). It will be reported later in both the survey and teacher leader interviews that students who are from a traditional background and then exposed to an inquiry-based format sometimes have difficulty with the transition.

A Native American boy began to make tally marks to solve the problem. Emma said to him, "Whoa this isn't going to be efficient for us. Isn't counting by 21 faster than tally marks?" (She told him what to do rather than letting him think of another way himself). After thinking about what Emma said, the boy began to count by groups of 21. Although it is not "wrong" to tell a student how to approach a problem, with inquiry-based mathematics, the use of effective questioning to guide students to a solution strategy is preferred (retrieved from http://www.pbs.org/teachers/_files/pdf/TL_MathCard.pdf)

A Native American girl from the group mentioned earlier showed her strategy for solving the problem on the Promethean Board. Emma asked the class, "What should we call this strategy?" "Multiplying for division," she told the class.

Another girl said she used the "box strategy" and wrote on the Promethean Board:

	20	1
10	200	10
2	40	2

Emma mentioned to the class that this was a great way to check answers. Using the box strategy to solve a division problem is difficult, but once a student has a divisor and quotient, he or she can multiply them together to see if the answer is the same as the dividend.

Emma directed the students to put away their notebooks and take out their math workbooks. She asked the students to "turn to page 53, put their name on their paper, and work together" to solve the problem on the page. She told them to share their strategies and that they should be able to walk their partner through the steps to explain how the answer was reached. Emma told the students to find a partner and a place to work in the room. The students worked on the page 53 problem for the rest of the period.

After reviewing my field notes, I classified the Level of Engagement for the observed instruction as a 3 (out of 5; Franke, Carpenter, Levi, & Fennema, 2001). Emma demonstrated that she recognized the benefit of children solving problems in ways that made sense to them. Students were allowed some opportunity to discuss their solutions. And she did listen to what students said about their mathematical thinking.

MADISON

I was a participant-observer in Madison's classroom during most of my classroom visits. There were an odd number of students (due to an absence) my days there, so, at Madison's invitation, I would play learning games with the remaining student when work was to be done in pairs. Had I not been there, I do not know whether Madison would have avoided the pairing strategies activity, if she would have left out a student for that task, or if she would have made a modification affecting just a few students, like having three students form a three-person group, while their peers were all in pairs. My inclination would have been that she would have formed one group of three students.

On my first visit, the class was working with division clusters using multiplication. Madison had written on the white board: $190 \div 2 =$ ___. She asked the students to think about how they would solve the problem. (See Appendix G: Diagrams 1-2)

Madison asked the students to copy in their notebook:

1. Find some factor pairs of 1100
2. Write about how you found each pair.

Madison mentioned, “This is an individual activity. The most important part is how you write your explanation. Here is a little hint, you can think of 1100 as 1000 and 100 so if a number goes into 1000 and it goes into 100 it will go into 1100.”

Students worked to find the factors of 1100. Afterward there was whole group discussion of factors of 1100. Some of the factor pairs and explanations:

2X550 and 5 X 220 The boy said that he knew 5 goes into any number that ends in a 5 or a 0.

A second student inaccurately offered: 4 X 225. The student doubled and halved 2 X 500

A girl offered 20 X 50 = 1000 and 20 X 5 = 100, 20 X 55 would be a factor pair

Another boy offered 10 X 110

Madison asked another boy, “Does 25 go into 1000?” The boy said that it does, “It goes 40 times.” Madison asked, “How many times does 25 go into 100?” The boy said, “It goes in four times.” Madison asked, “So what does that tell you?” The boy said, “44 times 25=1100.”

After that solution was given, another student offers 22 X 50 by halving and doubling. After the student finished Madison told the students that she will be looking at the factor pairs and how the students explained them.

While the students continued to find factor pairs of 1100, Madison explained the math game binders to me that were in the back of the classroom. Students at Roosevelt elementary each have a “math game binder.” The purpose of the binders is to provide students a deeper understanding of numbers and their meaning by playing the math games. The idea is that through continued playing of the games students will improve their accuracy, efficiency, and math fluency.

Madison told me that students are asked to play a minimum of ten math games per week as their homework at Roosevelt. New games were regularly added to the binder as new math topics were introduced. Students were asked to work on games that challenged their math skills first and then were asked to reinforce the skills by playing other games.

The math game binders were due back to Madison on Wednesdays. When students finished a game, they put their name, date, the name of the game, and how many times they played the game on a sheet inside the math game binder. A parent or guardian then needed to sign the sheet for the games to be counted for that week.

Thursday after school, Madison played the math games with any student who did not successfully complete the ten-game minimum. Scheduling conflicts were very rare. If students already have an appointment, they stay after school on Friday. The math game binders are the students' homework every week, and very little (in any) other math homework is sent home, so students take the math game binders very seriously, and see it as a required time commitment. Kendall (a pseudonym), the Roosevelt math teacher leader, also played math games after school with students who needed to play more games to meet the weekly requirement.

Students are aware that they will be completing at least ten games for homework each week. This has helped eliminate forgetting math game binders and sign-off sheets from home; this is also the reason why the math game binders are due back on Wednesday, and those without their parents’ signature play the games after school on Thursday (or Friday).

I asked Madison if she had difficulties with parents signing the math game binders and she said,

> "As far as parents forgetting to sign off on the homework (math game binders), this doesn't happen often. If the kids forget them or the parent forgets to sign the binder for Wednesday, they know they can get them (the games) played or signed on Wednesday night. I treat the math games as a responsibility, just like we have in the real world. If you forget something, you usually have a certain amount of time or another chance to remember. And if you do not do your responsibility on your own, instead of a punishment, you just have to do it. They seem to get this, and aren't resentful about it. As fifth graders, I have the students call their parents on the phone, instead of me taking care of it. They make arrangements for after school plans, and it's about the students fulfilling their obligations."

In my four observations of Madison's classroom, I noticed that students played math games that accompanied the *Investigations* curriculum on three of the four visits. Perhaps it is the use of the games as both in-class activities and as Roosevelt homework that has helped student achievement at Roosevelt elementary.

Based on the four observations of Madison's classroom, I categorized her Level of Engagement in Children's Mathematical Thinking as a 3 (out of 5; Franke, Carpenter, Levi, & Fennema, 2001). Again, it was difficult to make a thorough analysis of the engagement levels based on only four visits. All children were engaged, Madison was interested in the different strategies presented, and she honored all of the strategies, but I only had the opportunity to observe students presenting strategies to the entire class on one occasion.

Once I began my observations of the four teachers I realized that my "Levels of Engagement Scores" did little to indicate why RCAS might be prone to point to Roosevelt as the strongest implementation site. Although Roosevelt was not apparently weaker than the other sites, all the four sites demonstrated strong inquiry-based math implementation. That being said, Roosevelt may be advantaged by its Thursday after-school game sessions to make up for games not played at home. High expectations and student responsibility could be a factor in the school's success.

MARTIN

On my first observation day in Martin's classroom, the special education teacher (who was also the former elementary mathematics coordinator) was assessing all of the students on their "learning targets." They had to answer multiple choice questions that dealt with factors and multiples. In addition students had to mark whether they were "sure" or "unsure" of their selection. Familiar with inquiry-based math, she was interested in knowing what students were sure about and unsure about, as well as whether students answered correctly. On the assessment the students answered problems of the following nature that checked terminology and relationships:

1. 8 is a factor of which number?
   a. 2 b. 36 c. 24 d. 4 (correct answer is c. 24)

2. 27 is a multiple of which number?
   a. 7 b. 9 c. 54 d. 270 (correct answer is d. 270)

3. Which numbers are multiples of 8?
   a. 8, 16, 24, 32 b. 2,4,6,8 c. 32, 48, 64, 81 d. 1, 2, 4, 8
   (correct answer is a. 8, 16, 24, 32)

On my fourth observation in Martin's classroom, the problems were revisited by the special education teacher who had come back to review the assessments with the students.

Another day when I observed division being practiced in Martin's classroom, he wrote the division problem 536÷38 on the board. He said to his class, "Write a story problem to go with the division problem. Solve the problem and give me the quotient (I liked how he used quotient rather than "answer."). He said, "For example, I have 536 sheep. I want to give them to 38 people. How many sheep will each person get?"

Students worked by themselves at their respective tables to solve the problem. I asked one girl what her story problem was and she said, "I have 536 cherries and 38 cups. How many cherries will be in a cup?" She had used a strategy similar to the "hangman" or "seven" strategy that I witnessed in Hannah and Emma's classrooms. (See Appendix F: Diagram 1) I asked her why she chose to use 10. She told me that it was a friendly number, along with 10, 5, 2, and 1: they were all friendly. I asked her what the 4 meant in her answer; she told me that there must have been 4 cherries left over.

Martin called the class back together and the girl I had visited with shared her work with the entire class. A second Native American girl came to the front of the class and shared how she solved the problem. She spoke quietly; Martin reminded the class to please be quiet, "We need to pay attention**."** (See Appendix F: Diagram 2)

Martin asked her to explain what she did next: She said that she added the 10 + 2+2 to get 14 and 4 was the remainder between 536 and 532. Martin asks the class if anyone had worked the problem differently than the two ways presented. No one volunteered.

Martin next gave students the problem 739÷26, again asking the students to come up with a story problem and to solve it. Martin circulated around the room. He made the comment to his students, "It is good to see that most of you have moved away from the circles and tally marks."

A boy near me solved the problem using "the hangman strategy" (also called the 7 strategy because the division problem looks like a 7). This strategy allows students to find the quotient without relying strictly on the division algorithm. (See Appendix F: Diagram 3) The student was able to solve the problem with his method; it only took a few more subtractions.

In my four observations of Martin's classroom, I noticed that students were first directed to work on a problem individually. After ten or fifteen minutes, they were able to to compare results with other students at their table, Martin, or his classroom aide. After the students had a chance to work on their problem, their attention was directed to the front of the classroom where individuals shared their solution strategies for the problem to the entire class.

For the lessons I observed, I classified Martin's Level of Engagement with Students' Mathematical Thinking as a 3 (out of 5; Franke, Carpenter, Levi, & Fennema, 2001), although this classification needs even more caveats than the others. On one of the days I observed in his room students worked on an end of the unit assessment, and on two other visits the special education teacher was leading the math instruction in the classroom. In a different way, however, it is perhaps tell-tale that for three of the four days I had randomly selected to be in his classroom, other tasks than his charge to lead math learning steered what transpired.

There may have been a chance that my observation influenced teacher practice, but I realized that if it increases the frequency of depth with which a teacher implements Project PRIME (and its underlying elements – i.e. the *Investigations* curriculum) then the better the implementation will be for considering my ultimate question about math instructional strategy and American Indian students.

Survey Data

The first portion of the online survey which was conducted using Survey Monkey, concerned teacher demographic information. The reported information validated the assertion that most elementary teachers are white female teachers. (See Appendix H: Question 1-2) This matches RCAS teacher demographics, as well as those of South Dakota, and the U.S. writ large

The majority of respondents (74%) came from two of the four schools: Jefferson and Lincoln. I have established a good relationship with the elementary teacher leaders at the two schools, which could be a reason that a greater number of their teachers responded. (I was a familiar inquirer.) The teacher leaders at those schools likely encouraged their teachers to participate in the survey. (See Appendix H: Table 2)

I was not familiar with the teacher leaders at Washington and Roosevelt before I interviewed them in fall 2008. The elementary teacher leader interviewed at Washington was new to the school building that year and did not encourage her teachers to take the survey (although I have no evidence that she discouraged it either). After our interview together she asked if she should get her teachers to take the survey; however, the survey deadline had already expired.

Even fewer teachers responded to the survey from Roosevelt. The school does not have a large Native American population as the other three; but Native American students *do* attend Roosevelt (as noted earlier, Roosevelt's Native American enrollment in 2007-08 was 96 (24% of the enrolled students). In further investigating my survey data, I discovered that the Roosevelt teacher leader[3] did not complete the survey. Perhaps her approach was a reason why few Roosevelt teachers chose to participate (See Appendix H: Tables 2-3).

Of the respondents, 71% (27/38) had taught at their current elementary school for less than five years. (See Appendix H: Tables 2-4), while 42% (16/38) had taught for less than five years. The information from Table 2 and Table 4 suggest that there is teacher mobility within the RCAS elementary school system (as the focus case of Emma, shared earlier, illustrates).

Teacher Beliefs and Preparedness

The online survey consisted of closed-response questions (Dillman, 2007) that utilized either a 5- or 4-point Likert scale. Questions involved self-reported data on teacher beliefs and preparedness, teacher knowledge, and mathematics instructional practices and routines. Respondents were to strongly disagree (1 point), disagree (2 points), neutral (3 points), agree (4 points), or strongly agree (5 points).

Although teacher self-reports do not work very well for measuring certain dimensions of teaching practice, studies have shown that teachers' self-reports of their teaching in anonymous sample surveys are highly correlated with classroom observations (Mullens & Kasprzyk,1999) and are effective in describing and distinguishing among

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[3] The survey was anonymous, yet demographic information included school and current position (K-5, teacher leader).

different types of teaching practices (Mayer, 1999). Yet as a caveat, according to the research literature, standards-based (inquiry-based) mathematics tend not to be implemented deeply in classrooms and studies reveal a mismatch between teachers' reports of their engagement with standards-based mathematics practices and evidence from their classrooms (Kazemi & Stipek, 2001; Mayer, 1999; Spillane & Zeuli, 1999; as cited in Hill, 2008, p. 65).When I first began to analyze the self-reported survey data, the responses were extremely positive and indicated acceptance to support an inquiry-based mathematics program at the four elementary schools. But if RCAS teachers are like those described in the literature, my survey effectively captures that teachers thought they were implementing inquiry-based practices to a greater or deeper degree than they actually were. The four classroom observations shared earlier leave intact this possible explanation.

The results of the first teacher belief survey question, "I enjoy teaching mathematics" surprised me. It has been widely documented that elementary teachers generally have an aversion to mathematics (Ball, 1989; 1997; Ball & Bass, 2000; Ball, Hill, & Bass, 2005; Ball, Lubienski,, & Mewborn, 2001; Hill, Rowan, & Ball, 2005). Nonetheless, the mean and median response results to the question were both "strongly agree" and the mean was 4.67 (on a scale of 5); 67% (24/36) strongly agreed that they enjoyed teaching mathematics. (See Appendix I: Table 1) My questionnaire did not ask whether teachers enjoyed teaching reading, social studies, or any other subjects, so I do not have a way to distinguish whether the enthusiasm for math teaching is particular for that subject area or part of a more general enjoyment of elementary teaching in general.

The second teacher belief question "I spend time during the regular school week to work with my peers on mathematics curriculum and instruction" also had a median and mode of "strongly agree," with two-thirds (24/36) of the teacher population strongly agreeing with the statement. The collaboration between the teachers and teacher leaders was triangulated through the interviews. As Lord (1994) reported, for a broader transformation, teachers should be confronted and collegiality should support/enable a critical stance toward teaching. The substantial agreement with another statement, "Teachers in this school regularly share ideas and materials related to mathematics" – verified that sharing strategies and practices were commonplace in the studied elementary schools. All but one teacher (35/36) teacher agreed to the statement. (See Appendix I: Table 1)

The teacher belief questions "Students generally learn mathematics best in classes with students of similar abilities" and "A student's culture and ethnicity has no bearing on mathematical learning" showed variation. Although "somewhat disagree" was the mode for each question (a view of reform, inquiry-based mathematics) with 37% (14/36) and 42% (16/36) respectively, the standard deviations for the two statements were large (1.271 and 1.389 respectively). Part of this discrepancy could be a result of how teachers view students who differ from the dominant culture (Delpit, 1988; 1995; Villegas & Lucas, 2002). But this mismatch between education and cultures is exactly what needs to be addressed in education, particularly teacher education (i.e. Achinstein & Barrett, 2004; Downey & Cobbs, 2007; Sleeter, 2001; Villegas & Lucas, 2002). (See Appendix I:Table 1)

The second block of survey questions also concerned teacher beliefs and preparedness but focused more directly on the factors related to effective mathematics teaching. The Likert scale was changed to reflect the levels of importance (very important, important, somewhat important, and not important) as the question responses.

Many of the teacher responses in this block were positively aligned with inquiry-based teaching practices. Developing students' conceptual understanding of mathematics was considered "very important" by 78% (29/37) of the teachers, while the other 22% (8/37) considered developing students' conceptual understanding "important." Taking students' prior understanding into account when planning curriculum and instruction was measured "very important" by 68% (25/37) respondents while the remaining twelve considered it "important." Having students participate in hands-on activities to learn a math concept was considered "very important" by 78% (29/37) respondents and the remaining eight rated the factor "important." (See Appendix I: Table 2)

The third block of questions focused upon teacher knowledge and beliefs. Respondents were asked to respond to the close-ended Likert scale questions: I disagree (3), I agree somewhat (2), or I totally agree (1).

In the first question in that block, teachers responded to the statement, "An elementary age child is unable to solve math problems unless he or she has been taught problem solving strategies." Following the line of inquiry-based mathematics instruction, 81% (30/37) of the respondents "disagreed" with the statement ("disagreed" was given a weight of 3). However, "I agree somewhat" was selected by 16% (6/37) and one person selected "I totally agree" to the statement. Inquiry-based math education suggest that mathematics teaching must build on students' learning and on their ability to pose and solve problems previously considered “too difficult” for their age-levels (Carpenter & Fennema, 1988; Fennema, Franke, Carpenter, & Carey, 1993); however, it can be helpful if teachers provide students with strategies in problem solving, such as working backward, simplifying and reducing, recognizing patterns, drawing and modeling, making a table or graph, as well as acting it out and simulating (Jarrett, 1999). (See Appendix J: Table 1)

Responses to “The most important goal of elementary mathematics is teaching children to add, subtract, multiply, and divide” followed inquiry-based mathematical philosophy with 98% (36/37) responding either “I disagree” or “I somewhat agree.” One person totally agreed to the statement. (See Appendix J: Table 1)

Again, following an inquiry-based philosophy, only 5% (2/37) disagreed with the statement, “Children are able to learn from listening to one another's explanations.” Peers reasoning with each other on how to solve math problems is an integral part of inquiry-based mathematics instruction (White, 2003). The remaining 24% (9/37) of the teachers somewhat agreed;” while 70% (26/37) “totally agreed” with the statement. (See Appendix J: Table 1)

Surprisingly, 55% (20/37) of the teacher responded “agree” to the statement, **“**Teacher demonstration is a critical part of a math lesson.” With inquiry-based mathematics, teachers act as facilitators of learning rather than demonstrators of how a problem should be solved. However, 22% (8/37) selected either “disagreed” or “strongly agree.” The results of this question perhaps indicate that some teachers feel the need to “show” students how to solve problems rather than allowing the students to experiment and reason through a problem on their own.

Aligning with inquiry-mathematics beliefs, 69% (25/37) of the teachers "strongly disagreed" with the statement, "An elementary child will be unable to solve math word problems without first learning how to add, subtract, multiply, and divide." One person "strongly agreed" to the statement while 28% (10/37) "somewhat disagreed." (See Appendix J: Table 1)

As I continued to analyze the survey responses, I realized that some of the questions regarding inquiry-based math instruction might not have been as strong as intended as the questions appear to have been read differently by the various responding teachers. "I agree somewhat" was the response selected by 50% (18/37) of the teachers concerning the statement, "Teaching children key words will help children to solve word problems." Only 19% (7/37) disagreed with the statement while 41% (11/37) totally agreed with the statement. Verbal cues can be an interfering factor in problem solving (Nesher & Teubal, 1975) and children often develop more efficient strategies on their own without looking for key words (Carpenter & Fennema, 1988). The survey responses indicated to me that some teachers felt it was necessary to teach students to look for "key words" rather than rely upon their reasoning skills. (See Appendix J: Table 1)

"I agree somewhat" was the response selected by 51% (18/37) of the teachers to the statement, "Facts should be so well mastered that the child can respond without thinking if drilled." Twenty-three percent (8/37) "disagreed" while twenty-six percent (9/37) chose, "I strongly agree." Although teachers should want automaticity from their students in answering facts, when problems are put in a meaningful context, students have the opportunity to experience the power of mathematics (Keijzer & Terwel, 2004; NRC, 2001; Roman, 2004). (See Appendix J: Table 1)

Fifty percent (18/37) selected “I totally agree” to the statement, “Children should be taught how to break a word problem apart to help them develop problem solving ability.” Eleven percent (4/37) disagreed, while forty percent (14/37) “somewhat agreed” to the statement.

At this point, the survey responses indicated that most teachers were on board with inquiry-based mathematics, yet there were varied responses to the degree (i.e. strongly agree vs. somewhat agree). It was also difficult to differentiate responses (i.e. it was not one or two people who responded in the same manner through the survey), and there was no pattern to which schools included skeptical responses.

The next block of questions concerned teacher beliefs and preparedness, but the closed-response questions involved factors and their importance for effective mathematics teaching. The Likert scale was again changed to reflect the levels of importance (very important-4, important-3, somewhat important-2, and not important-1) as the question responses. Teachers were asked to rate items in terms of their importance for effective mathematics instruction**.** (See Appendix K: Table 1)

The first statement in this block, “Providing concrete experiences before abstract concepts.” was rated “very important” by 62% (23/37) of the teachers, while 22% (8/37) indicated the practice was “important.” The remaining 16% (6/37) rated providing concrete experiences before abstract concepts to be “somewhat important.” “The multiple interpretations of the basic operations is symptomatic of a general feature of mathematics – the tension between abstract and concrete. However, this tension is an unavoidable challenge for school mathematics; the abstractness of mathematics is an important reason for its usefulness: A single idea can apply to many circumstances" (National Research Council (NRC), 2000, pp. 74-75). (See Appendix K: Table 1)

Developing students' conceptual understanding of mathematics was considered "very important" by 78% (29/37) of the respondents. The remaining 22% (8/37) deemed the practice "important." Similarly, taking students' prior understanding into account when planning curriculum and instruction was found "very important" by 68% (25/37) of the teachers. .The remaining 32% (12/37) indicated the practice was "important." So with both of these responses, all respondents suggested the more inquiry-based response was at least "important." (See Appendix K: Table 1)

Results for **"**Practicing computational skills and algorithms" were mixed. The standard deviation (.897) was larger; 30% (11/37) of the respondents considered the practice "very important." Forty-six percent (17/37) rated the practice "important" and 16% (9/37) considered it "somewhat important." These results align with what would be expected in teachers who support inquiry-based mathematics. More rated the practice "important" or "somewhat important" rather than "very important." A goal of successful inquiry-based mathematics implementation is a decrease in reliance on computational skills and algorithms. Research provides evidence that students will rely on their own computational strategies (NCTM, 2000, p. 86) which is a key element of cognitively-guided instruction (Carpenter, et al., 1999) and the *Investigations* curriculum. Several factors are involved in developing mathematical proficiency in students. Developing mathematical proficiency involves conceptual understanding, strategic competence, adaptive reasoning, procedural fluency, and productive disposition. These factors should be developed in synchrony with others; learning mathematics is not an all-or-none phenomenon (NRC, 2001, p 133).

Making connections between mathematics and a student's culture or background was considered to be “very important” by 35% (13/37) of the teachers; the plurality of teachers 49% (18/37) deemed it “important,” while 14% (5/37) said it was “somewhat important.” Just one respondent indicated that it was not important to make the connection between mathematics and a student’s culture. (See Appendix K: Table 1)

The survey results from this question were alarming to me. If “somewhat important” is the politically correct version of “not important” then 16% (6/37) teachers dissented from this idea, while just more than one-third of the teachers found it “very important” to make connections between students’ culture and mathematics.

Having students work in cooperative learning groups was considered to be “very important” by 35% (13/37) of the teachers. The majority (62%) or (22/37) of the teachers stated the practice was “very important” while 3% (1/37) said it was “somewhat important.” Creating classrooms that operate as communities of learners has been the focus of research and scholarship in mathematics education since the standards-based mathematics movement began (i.e. Ball & Bass, 2000; Lampert, 2001). (See Appendix K: Table 1)

Having students participate in hands-on activities to learn a math concept was deemed “very important” by 78% (29/37) of the respondents. The remaining 22% (8/37) considered the practice “important.” RCAS purchased manipulative kits for each classroom to support *Investigations* implementation, and professional development (provided by math teacher leaders or BHSU personnel) aid elementary teachers in implementing hands-on activities in their classrooms. (See Appendix K: Table 1)

The fifth block of questions addressed teachers' sense of preparation to achieve certain mathematical tasks within their classroom. As with the fourth block, the four-point Likert scale did not include a 'neutral' response. Teachers were asked to respond to the following directive when responding to the statements: Within the arena of mathematical processes, many teachers feel better prepared to guide and help develop student learning in some domains rather than others. How well prepared do you feel to provide guidance in the following at the grade level you teach? The responses were: very well-prepared (4), fairly well-prepared (3); somewhat prepared (2); and not prepared (1).

Seventy percent (26/37) of the teachers felt "very well-prepared" to lead a class of students using investigative strategies. Of the respondents, 24% (9/37) indicated they were "fairly well-prepared" while the remaining 5% (2/37) indicated they were only "somewhat prepared." In turn, 70% (26/37) of the teachers indicated they were "very well-prepared" to manage a class of students engaged in hands-on/project-based work. Nineteen percent (7/37) said they were "fairly well-prepared" and 11% (4/37) felt they were "somewhat prepared." Proper inquiry-based mathematics implementation is hard work. The teachers who responded "fairly well-prepared" or "somewhat prepared" may have begun teaching at RCAS after using a traditional mathematics program, or they may have limited exposure to professional development provided by RCAS that would strengthen their pedagogical content knowledge. (See Appendix K: Table 2)

Fifty-four percent (20/37) of the teachers indicated they were "very well-prepared" to respond to student diversity, while 30% (11/37) responded that they were “fairly well-prepared” and 16% (6/37) felt they were “somewhat prepared.” The largest variance in this category of responses occurred with the statement, “Use strategies that specifically encourage participation of females and minorities in mathematics.” Thirty-two percent (12/37) responded they were “very well-prepared,” another 32% (12/37) indicated they were “fairly well-prepared,” while 16% (6/37) were “somewhat prepared” and 19% (7/37) indicated they were “not prepared” to specifically use strategies to encourage participation of females and minorities in mathematics. (See Appendix K: Table 2)

The responses to the previous two questions tie into the central theme of my dissertation and the discrepant responses indicate to me that more research is necessary to ensure the needs of RCAS Native American students truly are being met. The majority of teachers felt “very well-prepared” to respond to student diversity, yet only 32% (12/27) felt “very well-prepared” to encourage females and minorities in mathematics.

Fifty-seven percent (21/37) of the teachers responded that they were “very well-prepared” to encourage students’ interest in mathematics; 32% (12/37) indicated that they were “fairly well-prepared” while 11% (4/37) responded that they were “somewhat prepared.” These responses seemed minorly inconsistent to some statements in the previous block of “teacher beliefs and preparedness” questions. For example, in the previous block of questions (Appendix K: Table 1), 69% (25/27) of the teachers responded they felt “very well prepared” to engage students in inquiry-based mathematics; yet only 57% felt “very well-prepared” to encourage students’ interest in mathematics. Perhaps there are some who know inquiry-based methodology but are not fully confident that they know how to encourage students’ interest in math.

(See Appendix K: Table 2)

The sixth block of questions concerned teachers' mathematics instructional practices and routines. The Likert scale was again changed to a five-point scale, with answers reflecting self-estimated degree of classroom implementation (4 – extensively, 3, 2, 1, and 0 – not at all) for each statement. Focusing most explicitly on the larger orientation of inquiry-based math instruction, 54% (20/37) indicated that the lessons they teach "extensively" emphasize problem solving rather than computation and memorization. Forty-one percent (15/37) selected the next degree (3). Three percent (1/37) selected (2) and three percent (1/37) selected (1). The teachers' responses indicate that teachers are making a concerted effort to implement inquiry-based mathematics strategies if greater emphasis is place on problem solving rather than number fact memorization. "Problem-solving ability is enhanced when students have opportunities to solve problems themselves and to see problems solved (NRC, 2001, p. 420). (See Appendix L: Table 1)

Discussing practices that are less common in inquiry-based mathematics classrooms, 54% (20/37) of the teachers selected the middle response (2) when responding to the statement, "To what degree do you use direct instruction when teaching?" Direct instruction is teacher- centered instructional practice that *can* be effective in helping *some* students learn basic or isolated skills (Kroesbergen & Van Luit, 2003). (See Appendix L: Table 1)

In turn, competition in the classroom was rarely encouraged by 54% (20/37) of the teachers and 30% (11/37) do not encourage competition at all (0). (See Appendix L: Table 1)

The responses to the question, “To what degree do your rely on a textbook series to make instructional decisions?” resulted in a standard deviation of 1.175 which indicated a wider range of responses. Sixteen percent selected “4 – extensively.” Thirty percent (11/37) selected “3,”another 30% selected “2” while 16% selected “1.” Eight percent (3/37) did not make instructional decisions based upon the textbook. In 2009, through conversations with Washington and Jefferson teachers, the *Investigation* curriculum is followed closely, yet individual teachers may make instructional decisions on the pacing. Grade-level teachers may not necessarily be on the same page on a given day, yet they are within the same vicinity. (See Appendix L: Table 1)

Professional Development

In other survey questions I asked directly about teachers' professional development practices. Thirty-four teachers responded to the professional development questions. Of these, twenty-four (71%) teachers indicated that they had taken courses offered through Project PRIME, while ten (21%) indicated that they had not had any professional development through the initiative. Because my survey was directed specifically at Jefferson, Roosevelt, Washington, and Lincoln elementary schools, I had an under-sampling of teachers with Project PRIME exposure. The amount of teaching experience in RCAS system at the time of the survey may have been a reason why 21% had no professional development through Project PRIME at this point in time.

The respondents who indicated that they had taken courses through Project PRIME were then asked to state how many total credit hours they had participated in. The responses were spread out with six teachers (the teacher leaders) indicating that they had attended over 100 hours of professional development. (See Appendix M)

The survey finished with four short-answer questions. The first question read, “Are there any patterns that you have noticed in terms of who does well and who struggles in your mathematics classroom? If so, please briefly describe.” The second question asked, “Do you know where you can access information about teaching American Indian students? If so, briefly describe.” The third question read, “Have you used the Title VII resources link available on the RCAS website? If so, briefly describe.” The last question read, “What do you think is/are the most important outcome(s) of your math instruction?”

Regarding question one, seven teachers indicated that students who had been exposed to the *Investigations* curriculum in earlier grades seemed to do better and/or those who hadn’t previously been exposed seemed to investigative strategies struggled more. Four teachers stated that the absence of parental support was evident in some students. A Native American parent shared with me: “Parental involvement is a concern of teachers. Native families are very much involved in their kids’ lives. Our involvement may look different from what the teacher expects, but we still have it.”

Three respondents mentioned Native American students struggling more, particularly students who move back and forth from the reservation. But one respondent wrote, “I have noticed that students respond to me as a Native person. They are more willing to work harder and like math more.” (See Appendix N: Question 1)

Nine respondents answered “no” to question two, “Do you know where you can access information about teaching American Indian students? If so, briefly describe.” Seven teachers mentioned that they could obtain information from their math teacher leader, and four respondents mentioned that RCAS had an Indian Education office that would be a resource. None offered further elaboration, so it was unclear whether even those who knew where to find resources had ever actually done so. (See Appendix N: Question 2) The hesitation by some and lack of knowledge of others concerning available resources to help teachers better serve the Native American population is an issue that should be addressed at schools that serve this population. The RCAS OIE has a library of Native American resources that can be checked out by teachers, parents, and children to inform them about Native American (particularly Lakota) culture.

Question three read, "Have you used the Title VII resources link available on the RCAS website? If so, briefly describe." One response read, "No, I forgot it was there" while a second one read, "No, but I can go to my school's Title VII person and I do." However, the rest of the responses were a simple and thus resounding "No." (See Appendix N: Question 3)

The fourth question, "What do you think is/are the most important outcome(s) of your math instruction?" rendered varied responses. Some of the responses were, "get my students to think," "become confident in the mathematical ability" and "to become better problem solvers." Even though they had just answered direct questions about instructions and resources for Native American students, none of the respondents here made a reference to Native Americans, closing the achievement gap or anything similar. (See Appendix N: Question 4)

V. Conclusion and Recommendation for Further Study

Primary research question: **What is the relationship between teacher attitudes toward implementing an inquiry-based mathematics curriculum with the**

achievement and attitudes in Rapid City Native American elementary schools students?

As evidenced by the survey results, 67% (28/38) of the surveyed teachers strongly agreed that they enjoyed teaching mathematics and another 25% (9/38) somewhat agreed with the statement. Only a lone teacher responded with "somewhat disagree." Presuming these responses are candid, this indicates that the vast majority of surveyed teachers enjoyed teaching inquiry-based mathematics with *Investigations,* which in turn would seem to have a positive effect on how Native Americans perceive learning with inquiry-based mathematics, if, as described earlier, inquiry-based strategies are more responsive to cultural background and thus likelier to be successful.

Other survey responses were skewed toward an efficacious attitude within the teachers. More of the responses were in alignment in inquiry-based mathematics beliefs rather than traditional beliefs.

The classroom observations provided evidence that teachers were following the recommendations made by RCAS and the teachers' respective math teacher leaders to improve instruction; however, the observations revealed only partial facility with inquiry-base methods (due to the number of classroom observations per teacher). The teachers follow the *Investigations* curriculum closely; in the past some scholars would argue that a textbook should not be the "entire curriculum" but where *Investigations* is inquiry-based, it could be argued that it is better that the teachers closely follow the suggestions provided in the teacher's manual, provided they receive training to implement the curriculum appropriately (Schoenfeld, 2002).

Lessons Learned with Investigations Implementation

The early years of *Investigations* implementation was challenging for two reasons. First, an "invitational model" was used and teachers could chose to adopt inquiry-based mathematics (*Investigations*) or go with a traditional curriculum. Second, there were more teachers resistant to changing their practice at the beginning of Project PRIME when *Investigations* was introduced as a possible curriculum. Since that time, many of the teachers resistant to change have retired and the district's steady embrace of Project PRIME and *Investigations* have both suggested that this is not just a passing fad. Teachers who are new to the school district are expected to adopt and follow inquiry-based mathematics by their building principals and elementary mathematics teacher leaders. New teachers to the district are encouraged to enroll in the BHSU courses ED 601 Foundations and Issues in Mathematics Education, ED 641 Understanding Student Thinking in Numbers and Operations and ED 651 Understanding Student Thinking in Algebra. The courses are included in the RCAS Professional Development publications that are distributed to teachers three times per year (fall, winter, summer).

Mathematics and Culture Interpretations

The relationship between Rapid City elementary teachers' perception between the teaching and learning of mathematics and a student's race and culture was informative. In the four classrooms that I observed, the teachers viewed the children as "students" rather than thinking of them in terms of their race and culture. However, Gándara (2008, p. 44) asserts that the well-meaning teacher who remarks, "I don't see color, I see children" is missing critically important information about students' needs and the resources they use as they negotiate the world and learn, such as how membership into a racial groups shapes experience, access to social and cultural capital, and perspectives. The leading response to the survey statement, "A student's culture and ethnicity has no bearing on mathematical learning" was "somewhat disagree." This could indicate that Roosevelt, Jefferson, Washington, and Lincoln teachers perceive that mathematics is not necessarily a culture-free subject, but it does not suggest a powerful embrace of seeing culture as a resource or a reason for substantive instructional modification.

Ogbu (1987, p. 319) stated that the failure of school personnel to understand and respect minority children's culturally learned behaviors often result in conflicts that obstruct children's adjustment and learning. Many of the students observed in RCAS classroom were what he calls *involuntary minorities*: they do not have the option of returning to a homeland or remigration; nor do they feel that white Americans have a right to discriminate against them because they too are citizens (1987, p 325). According to Ogbu, involuntary minority groups fare worse at school because of a necessarily oppositional stance to a dominant culture within a society that oppress them (Hamann, 2004, p. 401).

Although more can be done to raise RCAS American Indian student achievement, participation in Project PRIME by the mathematics teacher leaders may have aided the confidence and mathematics education efficacy of Rapid City elementary teachers concerning *Investigations* implementation. The responses to the survey questions about implementing an inquiry-based mathematics program were high. The majority of respondents recognized the importance of taking students' prior understanding into account when planning curriculum and instruction, having students participate in hands-on activities to learn a math concept, and encouraging students in inquiry-oriented activities. Moreover, use of these practices was observed in all of the classrooms (albeit partially), suggesting a link between understanding and inquiry-oriented practice.

The responses to the survey questions about their preparation to implement an inquiry-based mathematics program were high as well. The majority of the survey respondents felt very well-prepared to take students' prior understanding into account when planning curriculum and instruction; to engage students in inquiry-oriented activities, to have students work in cooperative learning groups, and to have students participate in hands-on activities to learn a math concept.

As with so many reform efforts where resources available to initiate but not necessarily sustain, the funding to provide stipends for teachers to participate in the classes through the grant no longer exists. Teacher Compensation Assistance Program (TCAP) money can be available, but how the money is allocated is a district decision. It had been stated that TCAP money would be provided to teachers who successfully completed "Understanding Student Thinking in Number and Operations" and "Foundations and Issues in Mathematics Education" (which I teach).

However, there appear to be some discontinuities between what is provided to build teachers' mathematical and pedagogical capacity to use inquiry-based mathematics through professional development (not necessarily within the classroom). RCAS provides professional development opportunities for their teachers and produces fall, spring, and summer brochures to inform teachers of classes available to them.

In 2008, 27 teachers enrolled in "Foundations and Issues in Mathematics Education" for the spring semester. Evaluations of the course and teacher (me) were high; I expected to have another large class in spring 2009 since teachers new to the RCAS system are encouraged to enroll in the classes. I went through the proper channels so teachers would be able to receive TCAP money and take the class for either BHSU graduate credit or recertification credit (whichever worked best for a teacher's situation). Yet, when the spring 2009 semester arrived, I was informed by the RCAS professional development district office that no one had enrolled in "Foundations." Fortunately for me, my CAMSE superiors informed me that Jefferson Elementary had received a 21st Century Grant from the South Dakota Department of Education to offer professional development. I was able to teach the class at Jefferson to interested teachers, and four teachers from Washington enrolled in the class as well. However to my knowledge, the Jefferson teachers will be the only teachers who will receive a stipend for participation (through the 21st Century Grant), not the Washington teachers. Had all the teachers enrolled through RCAS before January 7th, 2009, they would have all received TCAP money for the class (equivalent to the amount the Jefferson teachers will receive through the 21st Century Grant).

The original Foundations class listed in the RCAS professional development book was to be held at a newer elementary school in east Rapid City, where much of the new city growth is occurring. The Foundations course that I offered at Jefferson is more conveniently located for both the Jefferson and Washington teachers and this may have been a reason why no one had signed up for the course prior to January 7th, 2009.

This situation mentioned demonstrates the complexity of policy implementation to promote educational change. School reform may be that vulnerable to the choice of which school hosts the training. When I taught Foundations in spring 2008, the class met at a centrally located venue in the RCAS district. Perhaps this provides evidence about how dependent on serendipity improving Native American mathematics teaching and learning can be.

Teacher's attitude toward equity and inquiry based mathematics appear to be effected by years of teaching experience. As evidenced by the teacher survey, 32% of the respondents had two or less years teaching experience and 50% had over nine years of experience; this 50% included the well-experienced teacher leaders.

At the initiation of Project PRIME in 2003, there was a greater resistance to making the change from traditional mathematics teaching practices to inquiry-based than what is present today. One reason for the early resistance to implement inquiry-based mathematics was because an "invitational model" was presented to elementary teachers by some school administrators. Although the invitation model may have slowed *Investigations* acceptance and implementation, research shows that mandated dramatic changes often backfire when implementation is forced (Coburn & Stein, 2006; Hill, 2006). The RCAS mathematics curriculum committee chose *Investigations* - the inquiry-based mathematics curriculum, and a traditional program for teachers to choose to implement in their classrooms. However, the mathematics teacher leaders (funded by Project PRIME) were hired to work with the teachers who wanted to implement inquiry-based mathematics in their classroom.

The initial proposal did not have a directive that required administration to encourage teachers to implement the inquiry-based mathematics; however, as the project gained momentum, more administrators strongly suggested that their teachers implement the inquiry-based curriculum. At the time of my observations, the administrators at the four observed schools expected their faculty to use *Investigations* and follow recommendations suggested by the respective school's elementary mathematics teacher leaders.

A Transition from a Culturally Responsive to a Culturally Relevant Curriculum

For instruction to be culturally responsive, teachers must possess both culture and content knowledge of their students (Hankes, 1998, 2005). RCAS selected a curriculum that is more culturally responsive than traditional methods and parallels a Native American way of pedagogy. However, the tie-in is indirect and neither explicit nor intentional. Returning to some of the themes broached in Chapter Two, it makes sense to ask how RCAS use of inquiry-based math might be more overtly tied to Lakota and other Native American traditions. At the time of my study, the RCAS OIE was committed to working with parents and students to improve the low graduation percentage of Native American students. I never met the interim RCAS OIE director who was in place when I began teaching at BHSU, but his replacement's commitment to American Indian students and her personal assistance in Project PRIME meetings demonstrated to me that she was an asset to RCAS. With that in mind, I looked to mathematics education researchers who have been involved with culturally-relevant pedagogy and curriculum to provide guidance for RCAS administration for what could transpire for Lakota students in the RCAS region in the future.

In mathematics, the recommended approach for connecting home and school and provide success in classrooms with culturally diverse groups is called *ethnomathematics* (Apthorp, H.S., D'Amato, E. & Richardson, A., 2003); but research on the effectiveness of *ethnomathematics* for Native American students is limited.

In one example that might be pertinent to RCAS, Alaska Native people have taken a proactive role in promoting the integration of traditional knowledge with Western science traditions. Lipka (2005) has had a long-term professional relationship with Yup'ik elders, teachers, schools and communities. They have collaborated with him to develop a supplemental culturally based elementary math curriculum, *Math in a Cultural Context* (MCC). The program is based on Yup'ik cultural knowledge and seeks to bridge the culture of the community with that of the school. MCC was designed to create classroom and community interaction where mathematical and pedagogical knowledge connect in both the school and community context. Additionally, MCC was intended to include both Western reform-oriented instructional practices along with local ways of learning and knowing. Such a stance acknowledges both Delpit's (1988, 1995) point that non-mainstream students need access to the mainstream curriculum and the point that constructivists would emphasize, that learners use existing knowledge and understandings to make sense of the new.

Lipka and colleagues (2005) conducted case study research with two novice sixth-grade teachers using the MCC curriculum module, *Building a Fish Rack: Investigations into Proof, Properties, and Area*. One of the teachers was Yup'ik and born and raised in a rural Alaskan village and considered an "insider," while the second teacher was white and was born and raised in the "Lower 48" and considered an "outsider" with respect to the Yup'ik community. Ironically, the "insider" classroom was more teacher-driven, procedure was emphasized over content and collaboration between classmates was not encouraged. In contrast, the "outsider" classroom was aligned with reform-mathematics instruction. Because of her contextual familiarity, Doreen (the outsider teacher) and her students devoted more time and concentration to cognitively demanding work compared to what was evidenced in the insider classroom (Lipka, et al., 2005). The two case studies suggested that culturally responsive pedagogies can be practiced by those who are not a part of the culture, and likewise, those who are a part of the culture do not automatically teach in culturally responsive ways (perhaps because their "apprenticeship of observation" [Hammerness, et al., 2005] and other training has 'taught' them not to). Perhaps this anomaly also exists because the teachers' preparation and experiences as students themselves directed them in different directions.

Doreen (the outsider teacher) built her classroom community based upon the shared context of the local community and culture through the everyday activities in which she and her students participated (Lipka, et al., 2005). She used the curriculum to capitalize on community knowledge and established more culturally aligned ways of communicating and valuing; these are elements of place-based education, a concept inherent to indigenous education. While there are few (if any) Yup'ik students in Rapid City, Lipka's findings are relevant because of how they illustrate the prospective value of curricular and pedagogical adaptation.

Brenner (1998) conducted ethnographic research with Native Hawaiian children involved with the Kamehameha Early Education Program (KEEP) lab school where she looked to investigate cognitive approaches to mathematical teaching alongside a culturally relevant curriculum. Similar to Carpenter and Fennema's work, Brenner's (1998) research focused on studying the knowledge children bring with them to school when they enter kindergarten, before they have received any formal mathematical instruction (p. 225). By incorporating Hawaiian Creole English terms for some mathematics concepts, adding a game center, using manipulatives, and altering the sequence of topics to match what children had demonstrated easier or more difficult to learn, KEEP kindergarten students scored significantly higher on a standardized math test than a control group (Brenner, 1998).

Brenner and the KEEP teachers altered the sequence of topics to match what children demonstrated was easier and more difficult to learn; they integrated Hawaiian Creole English terms for some of the mathematics concepts, manipulatives to students' independent work, and a game center with mathematical content. Children who participated in the revised classrooms scored significantly higher on standardized math tests compared to the control group without the additional changes (Brenner, 1998).

Neumann (2003) used cultural connections associated with the Native American star quilt to teach mathematics, while the interdisciplinary nature introduced students to the social and artistic implications of the star quilt. The Native American star quilt is made from materials cut into rhombus, or diamond-shaped pieces and these quilts hold symbolic meanings representing life, spirituality, and community for Native American students. According to Collmer's research (as cited in Neumann, 2003), the star quilt is often connected in a personal way when used by friends and extended family to honor births, deaths, marriages, and graduations. The mathematics emphasized by Neumann includes concepts such as symmetry, reflection, rotation, angle measurement, geometric characteristics and properties, and numerical patterns. Neumann's stated learning goals for this lesson included demonstrating and applying the mathematics needed to make a star quilt, plus the exploration of the investigations and constructions needed to broaden students' knowledge of mathematical applications within a cultural and historical context.

Recommendation for Further Study

There are challenges ahead to improve Native American education in RCAS, and the entire nation; the journey begins with acceptance and trust between people of different cultures and background. Although I am non-native, I recognize the inherent need to increase the number of same-culture teachers for Native American students (Vandergriff, 2006). This is not because you need to be Native American to succeed with Native Americans. Anglo teachers (such as Doreen “the outsider”) who help students connect their background knowledge to their math learning can also be successful. Rather, I think the understanding that Meier and Stewart (1991) came up with in their study of when Latino/a students were most successful might apply here too for RCAS Native American elementary students. According to Meier and Stewart, Latino students fared better in districts with more Latino teachers because the very prevalence of Latino teachers was an indicator of that group’s relative political power and success. In places where Latinos had no political power, there was no pressure to assure schooling was responsive to Latino children.

RCAS has adopted an elementary math curriculum that lends itself to encouraging students to use their background knowledge in problem solving. In short, it is positioned to do better by Native American students, but as perhaps the distance some questionnaire respondents seemed to indicate when faced with questions RE: the salience of attending to culture. There may not be much political pressure in RCAS to change Native Americans’ math education; agreement that this would be good in an ideal world is different than a focused and committed effort that makes for such a transformation.

Yes we must all be able to cooperate and communicate with each other, but where education is involved, learning from someone whom a student can relate to because of background, etc. is advantageous to achievement. So is having a knowledgeable advocate for your success. A significant issue for Lakota students in RCAS and the rest of South Dakota is the loss of the Lakota (and Nakota and Dakota) language. A "Wolakota (Lakota way of life) Indian Education Strategic Plan" has been developed by the RCAS OIE, and Lakota language classes at the high school level were to be implemented (after the end of my study period). Currently Lakota I and II are offered at a central RCAS high school and Lakota III and IV courses have been developed for implementation in the near future. Although the addition of language classes would not affect math instruction per se, it might raise the awareness/responsiveness to culture issues in ways that turn out to be salutary for math achievement. And there may be a way to integrate the two disciplines: Lakota language and CGI mathematics.

Many native cultures' epistemologies and beliefs have developed over thousands of years of continuous living on the land. This connection to the land offers native peoples different ways of approaching knowledge, learning, understanding, and remembering (Rains, Archibald, & Dehyle, 2000). As our Earth continues to become "hot, flat, and crowded" (Freidman, 2008) perhaps the dominant culture will begin to listen to the wisdom of Native American elders.

A promising next step for RCAS would be to have someone work with the RCAS OIE, Lakota elders and teenage Lakota students (in Lakota language classes) to develop a culturally responsive mathematics curriculum supplement to *Investigations* that is based upon Lakota legends, similar to what Judith Hankes and Gerald Fast developed at the

University of Wisconsin-Oshkosh using legends from the Ojibwe, Oneida, and Menominee tribes of the Wisconsin region. Lambe (2003) stated that the elders' life experiences are very important when developing connections with Native American students in the learning environment. Many of these students believe people, like beings and processes in nature, have unique gifts, where each individual group holds a specific contribution or gift to bestow upon the learning community.

Perhaps using culturally relevant mathematics problems that also incorporate the Lakota language and tradition (such as Neumann, 2003) could help in schools where the math game "homework" is not consistently completed or returned. The director of the OIE and I have visited about this possibility. However, we both know that a grant opportunity must be found and a proposal written before a project can come to fruition. With two consecutive years of extensive cuts (2008-2010) to the RCAS budget, pursuing this venture is only available as an 'add on' if external funding is obtained.

Developing a culturally relevant project such as this has been a goal of mine since 2004 when I was the lead reader on Ben Sayler's (CAMSE director) NSF MSP proposal, "Lakota Counts" which morphed into the South Dakota Title IIA MSP "South Dakota Counts." The opportunity to read and peer-review the grant (the NSF MSP peer-review occurred while I served my NASA Einstein Fellowship in 2004, two years prior to being hired at BHSU) was an impetus for me to do something with the idea to develop culturally-responsive mathematics materials. As a non-native, I continue to work on developing relationships and trust with my Native American colleagues with whom I collaborate.

However setting up a possible inquiry-based culturally relevant math curriculum supplement does not ensure that such a document would be implemented by all receiving elementary teachers. Although the information is secondhand, I've heard of developed Native American curricula for RCAS that remained in some teachers' storage closet without ever being used. Also, if a project is fully developed, because it is not mandated, there is also no guaranteed that elementary teachers will be convinced that a culturally relevant tie-in for Native American students is necessary.

As Starnes (2006) concluded, "Too many things have been done in the past that cannot be undone. We must build bridges and rise above a difficult history to build bridges between us; we have to find ways to work together (p. 393). A goal of acculturation in our "hot, flat, and crowed" world would seem to benefit future generations more than an assimilationist perspective. Delpit (1995) asserted, "One of the most difficult tasks as human beings is communicating meaning across our individual differences, a task confounded immeasurably as we attempt to communicate meaning across individual differences, a task confounded immeasurably as we attempt to communicate across social lines, ethnic lines, cultural lines, or lines of unequal power (p. 66). These are issues that RCAS elementary teachers (and teacher in general) must work collaboratively to provide an equitable education for *all* students.

Teaching in the United States is one of the most challenging and least acknowledged professions available, but teachers must be cognizant of how their human and social characteristics influence teaching (Grant & Gillette, 2006). By honestly examining their attitudes and beliefs about themselves and others, teachers begin to discover why they are who they are, and can confront biases that have influenced their value system (Villegas & Lucas, 2002). The philosophy of education for all teachers should concern what is best for students; Native American, white or any ethnicity, we must follow educational paths that works for *all* children. *Mitakuye Oyasin* (We are all related).

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Appendix A

Correspondence between Native American pedagogy and Cognitively Guided Instruction (Hankes, 1998, pp. 22-23).

Native American Culture-based Instruction Principle #1	**CGI Example**
Teacher as facilitator – indirect rather than direct instruction	The teacher presents problems and trusts students to solve them. Students are encouraged to construct their own understanding as well as instruct one another.
Native American Culture-based Instruction Principle #2	**CGI Example**
Problem solving that is sense making (each student is allowed to solve problems in any way that makes sense to that student)	Students are allowed to use tools in any way that makes sense to them, i.e., manipulating concrete objects, drawing, invented procedures, etc.
Native American Culture-based Instruction Principle #3	**CGI Example**
Problems based culturally and on the lived experiences of the students.	Problems are based on shared classroom experience, e.g. a story, a science unit, students' lives.
Native American Culture-based Instruction Principle #4	**CGI Example**
Cooperation rather than competition	Children are allowed to work in teams or individually and are asked to share their solutions strategies. Each student's thinking is accepted and respected.
Native American Culture-based Instruction Principle #5	**CGI Example**
Time generous rather than time driven instruction	Class time is spent solving several complex problems with understanding. Enough time is granted to discuss problems thoroughly.

Appendix B

"Levels of Engagement with Children's Mathematical Thinking"

Level 1: The teacher does not believe that the students in his or her classroom can solve problems unless they have been taught how.
- Does not provide opportunities for solving problems.
- Does not ask the children how they solved problems.
- Does not use children's mathematical thinking in making instructional decisions.

Level 2: A shift occurs as the teachers begin to view children as bringing mathematical knowledge to learning situations.
- Believes that children can solve problems without being explicitly taught a strategy.
- Talks about the value of a variety of solutions and expands the types of problems they use.
- Is inconsistent in beliefs and practices related to showing children how to solve problems.
- Issues other than children's thinking drive the selection of problems and activities.

Level 3: The teacher believes it is beneficial for children to solve problems in their own ways because their own ways make more sense to them and the teachers want the children to understand what they are doing.
- Provides a variety of different problems for children to solve.
- Provides an opportunity for the children to discuss their solutions.
- Listens to the children talk about their thinking.

Level 4: The teacher believes that children's mathematical thinking should determine the evolution of the curriculum and the ways in which the teachers individually interact with the students.
- Provides opportunities for children to solve problems and elicits their thinking.
- Describes in detail individual children's mathematical thinking.
- Uses knowledge of thinking of children as a group to make instructional decisions.

Level 5: The teacher knows how what an individual child knows fits in with how children's mathematical understanding develops.
- Creates opportunities to build on children's mathematical thinking.
- Describes in detail individual children's mathematical thinking.
- Uses what he or she learns about individual students' mathematical thinking to drive instruction

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Appendix C

Classroom Layouts

Diagram 1. Hannah's Classroom

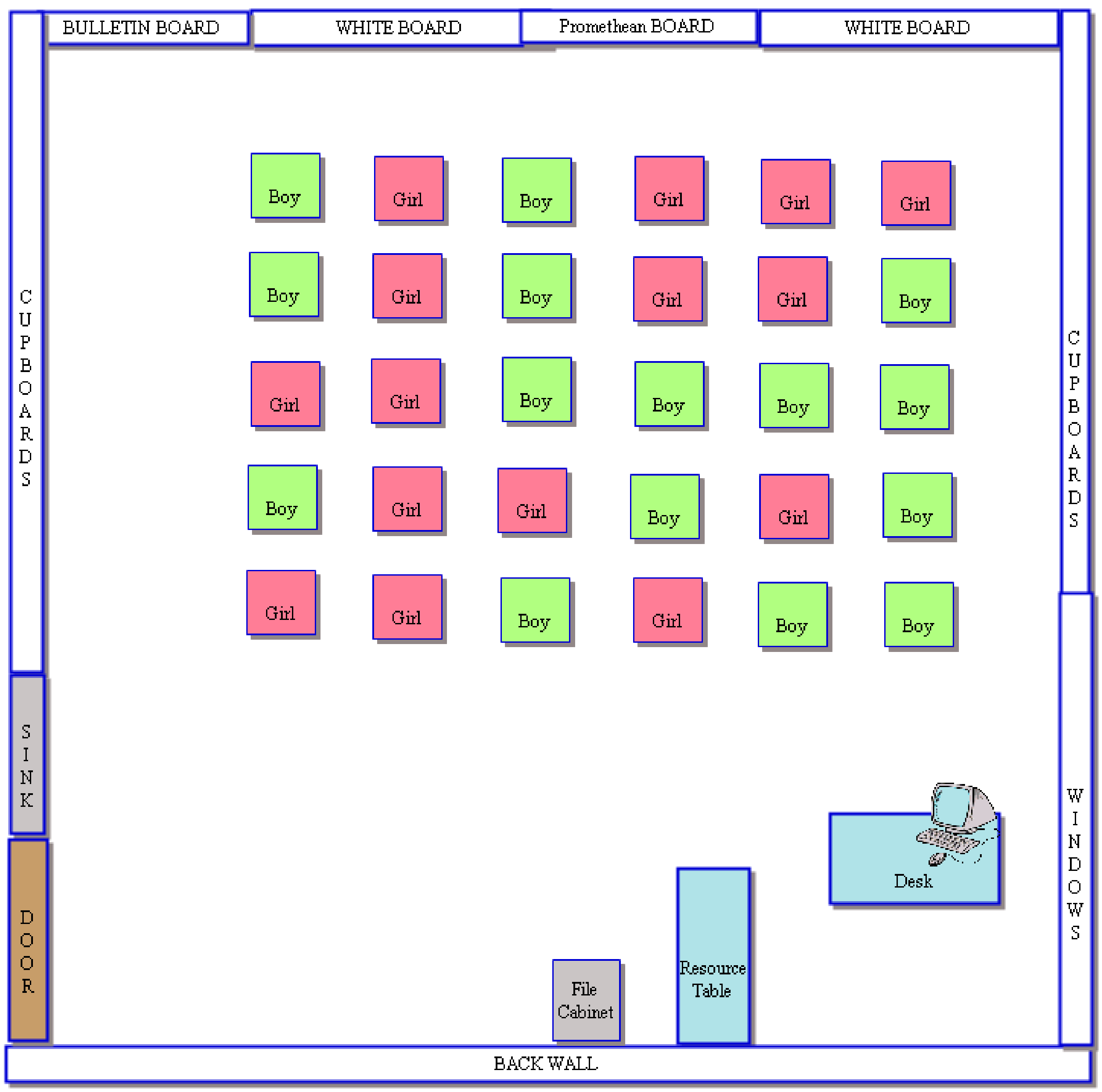


Diagram 2. Emma's Classroom

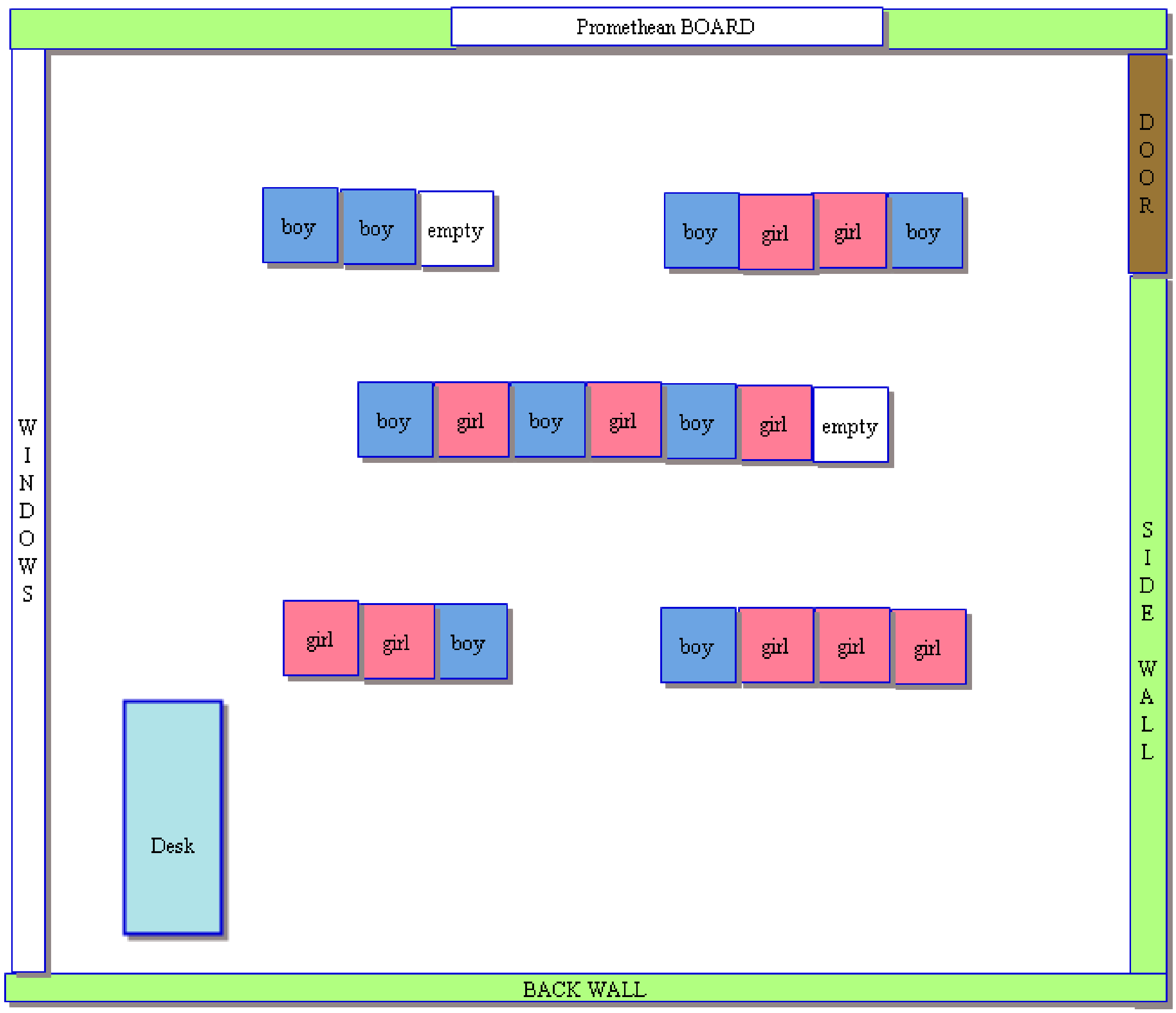


Diagram 3. Madison's Classroom

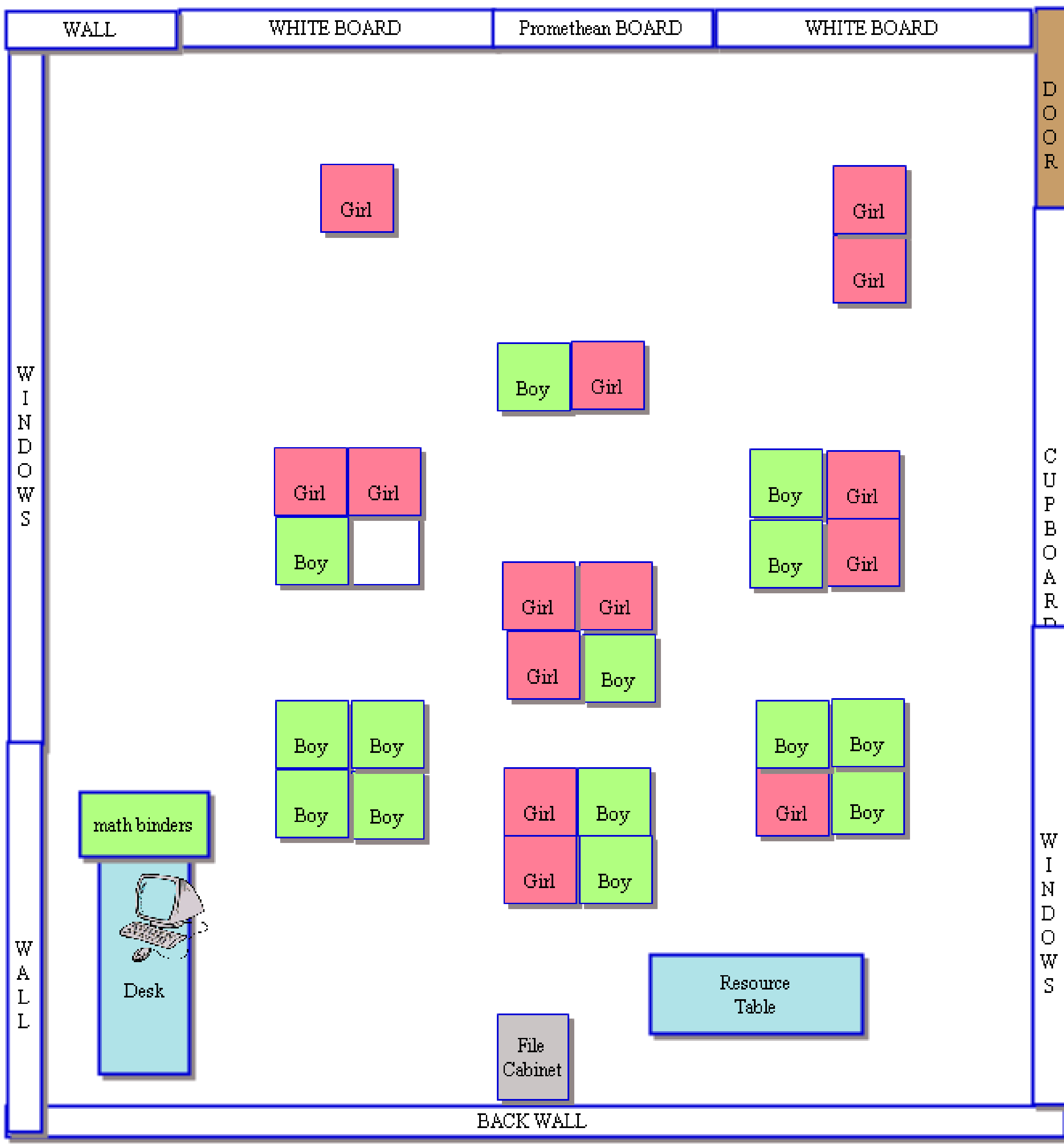
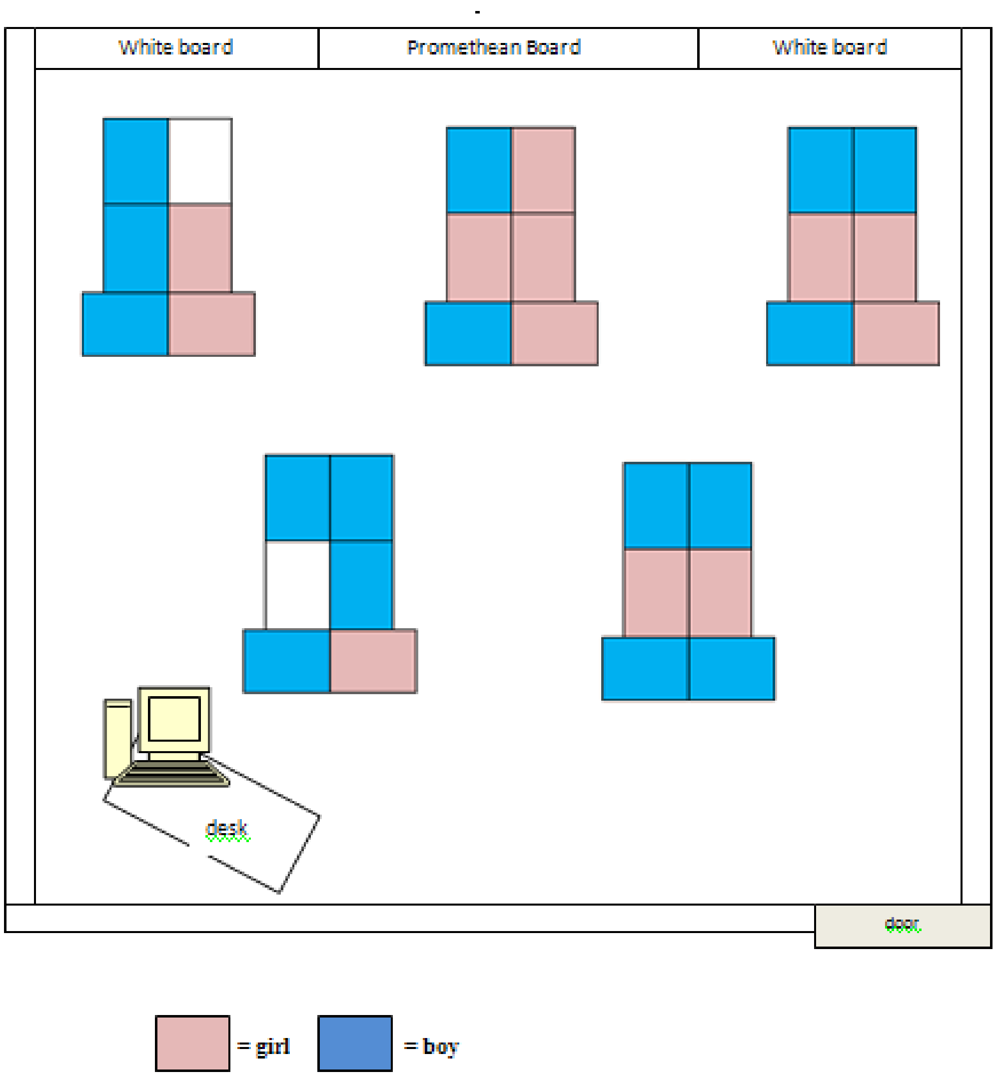


Diagram 4: Martin's Classroom



Appendix D

5th Grade Student Achievement Data

Table 1. Washington Elementary 5th Grade Student Achievement Data

+P = Proficient or better   +B = Basic or better

		2003		2004		2005		2006		2007		2008	
		+P	+B	+P	+B	**+P**	+B	**+P**	+B	**+P**	+B	**+P**	+B
Washington	White	**31%**	85%	Group does not meet minimum population size		**84**	100	**67**	100	**47**	100	**54**	100
	American Indian	**18%**	78%	40	60	**52**	100	**37**	100	**58**	100	**53**	100
	Gap	**13%**	7%			**32**	0	**30**	0	**+11**	0	**1**	0

Graph 1

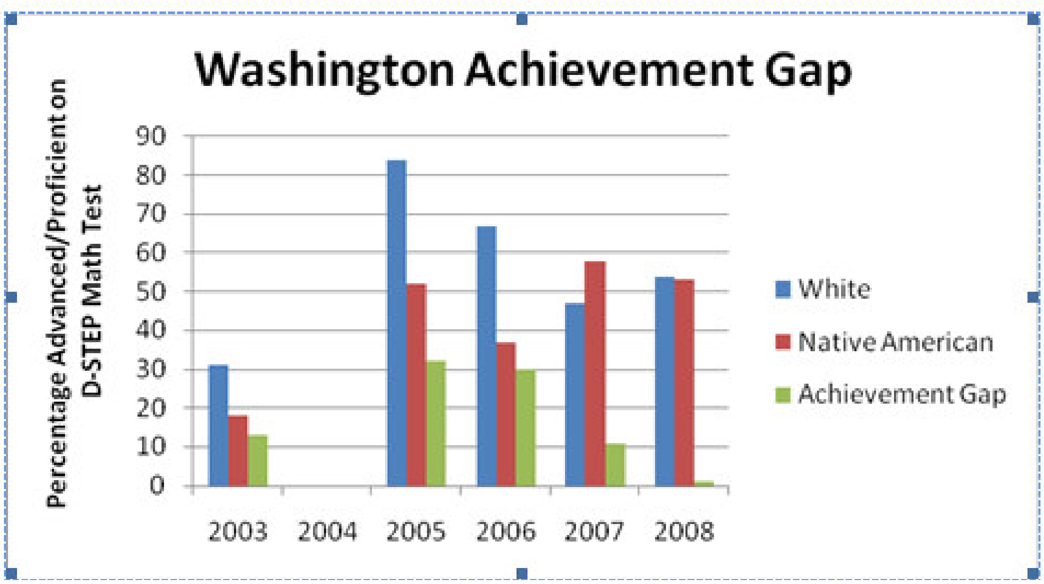


Table 2. Jefferson Elementary 5th Grade Student Achievement Data

+P = Proficient or better   +B = Basic or better

		2003		2004		2005		2006		2007		2008	
		+P	+B	**+P**	+B	+P	+B	**+P**	+B	**+P**	+B	**+P**	+B
Jefferson	White	**35%**	89%	**52**	100	73	100	**58**	100	**89**	100	**68**	92
	American Indian	**18%**	71%	**13**	100	Group does not meet minimum population size		**31**	100	**50**	50	**58**	100
	Gap	**17%**	18%	**39**	0			**27**	0	**39**	50	**10**	+8

Graph 2

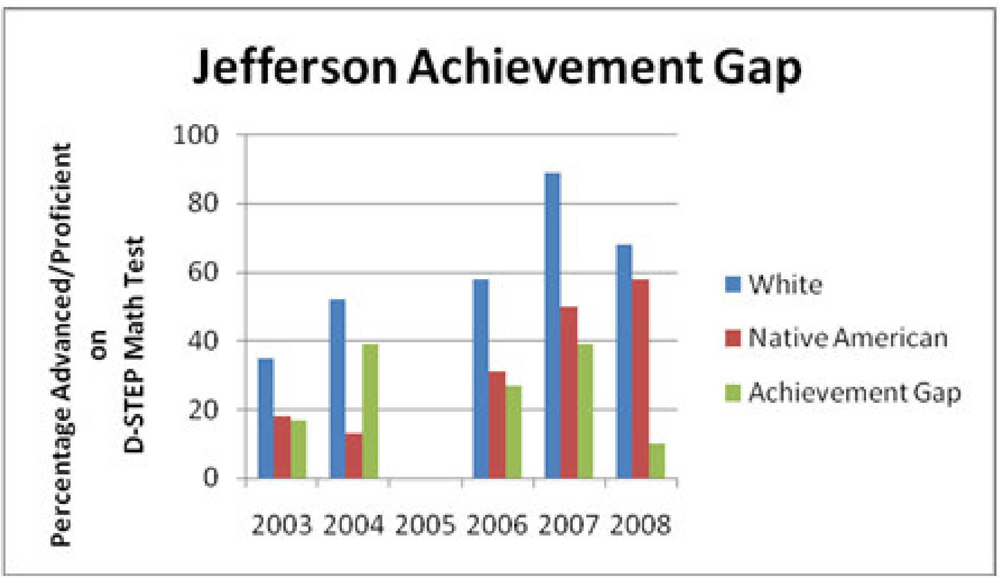


Table 3. Lincoln Elementary 5th Grade Student Achievement Data

+P = Proficient or better   +B = Basic or better

		2003		2004		2005		2006		2007		2008	
		+P	+B	**+P**	+B	**+P**	+B	**+P**	+B	**+P**	+B	**+P**	+B
Lincoln	White	**34**	93	**68**	100	**70**	100	**55**	97	**71**	100	**70**	100
	American Indian	**22**	84	**46**	99	**52**	100	**41**	100	**28**	100	**44**	97
	Gap	**12**	9	**22**	1	**18**	0	**14**	+3	**43**	0	**26**	3

Graph 3

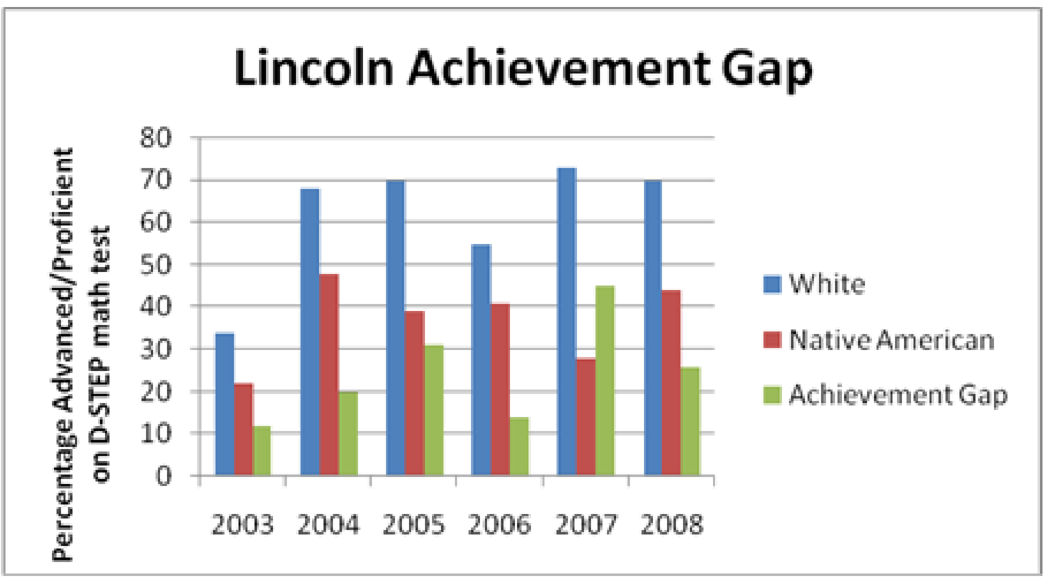


Table 4. Roosevelt Elementary 5th Grade Student Achievement Data

+P = Proficient or better   +B = Basic or better

		2003		2004		2005		2006		2007		2008	
		+P	+B	**+P**	+B	**+P**	+B	+P	+B	+P	+B	**+P**	+B
Roosevelt	White	65	100	**76**	100	**79**	100	75	25	87	100	**85**	100
	American Indian	Group does not meet minimum population size		**45**	100	**67**	100	Group does not meet minimum population size		Group does not meet minimum population size		**50**	50
	Gap			**31**	0	**12**	0					**35**	50

Graph 4

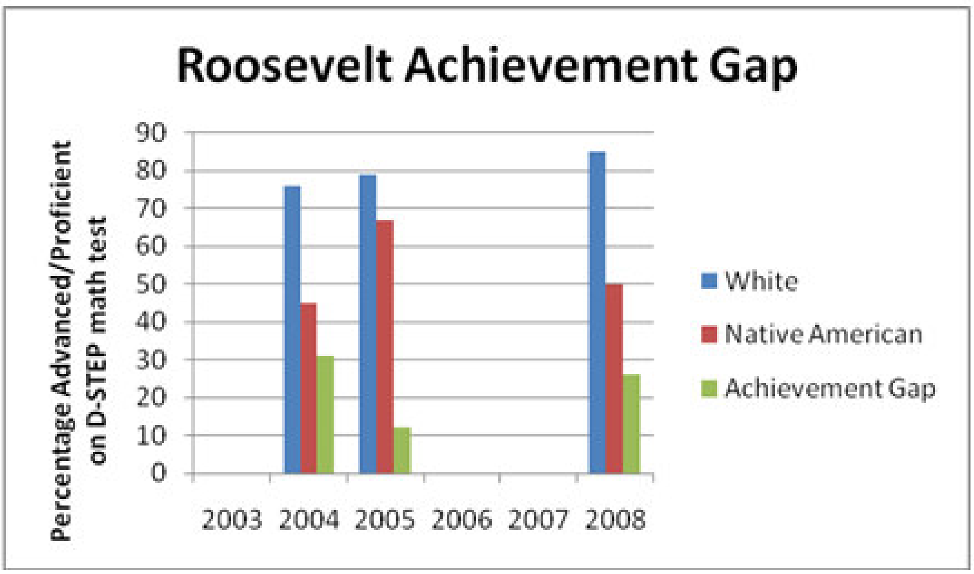


Table 5. RCAS 5th Grade Student Achievement Data

P = Proficient or better   +B = Basic or better

		2003		2004		2005		2006		2007		2008	
		+P	+B	+P	+B	+P	+B	+P	+B	+P	+B	+P	+B
RCAS District	White	55	93	79	99	79	99	77	99	80	99	87	99
	American Indian	18	78	45	100	37	100	46	100	48	99	53	98
	Gap	37	5	34	+1	42	+1	31	+1	32	0	34	1

Graph 5

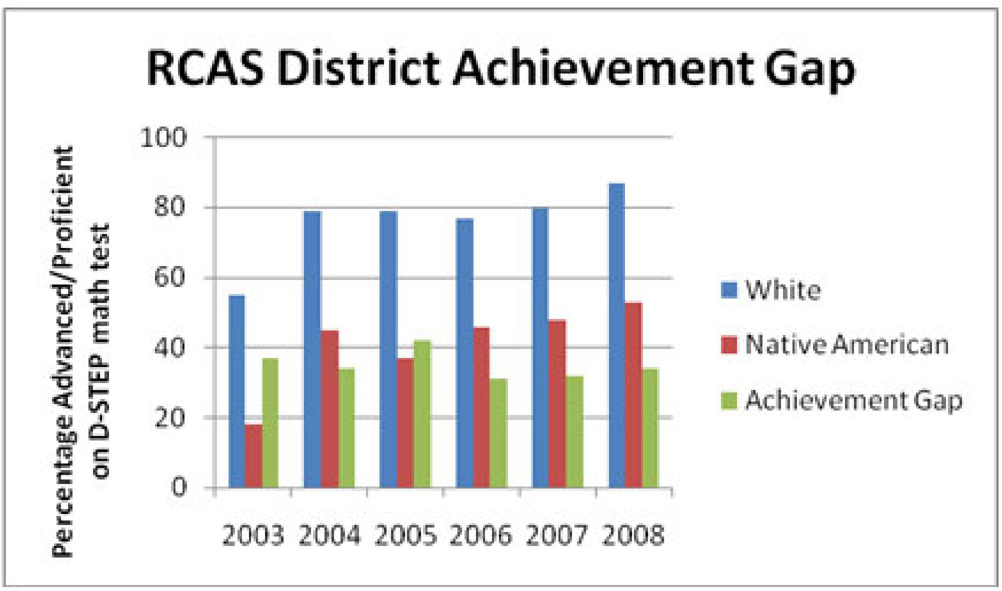
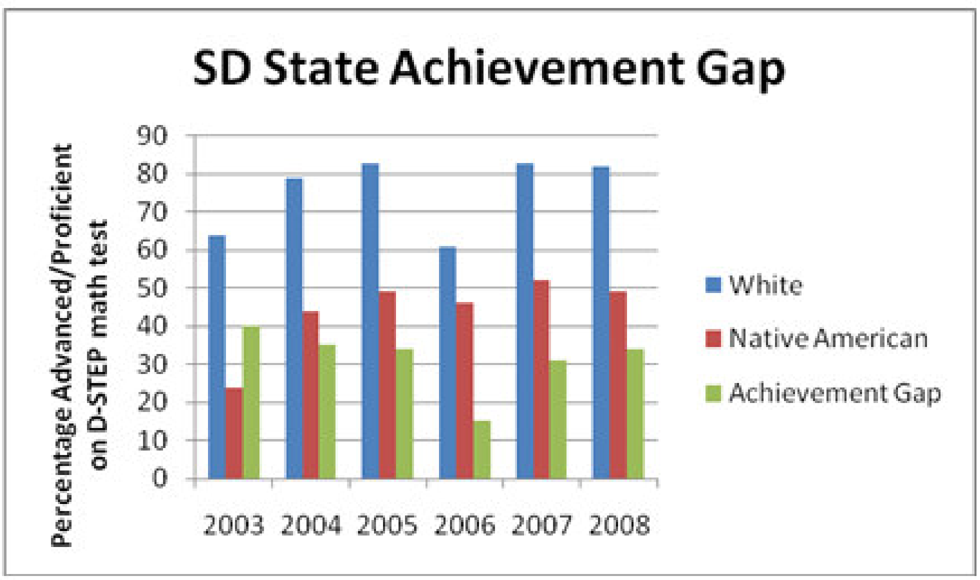


Table 6. South Dakota 5th Grade Student Achievement Data

P = Proficient or better +B = Basic or better

		2003		2004		2005		2006		2007		2008	
		+P	+B	**+P**	+B	**+P**	+B	**+P**	+B	**+P**	+B	**+P**	+B
State	White	**64**	94	**79**	99	**83**	99	**61**	100	**83**	100	**82**	100
	American Indian	**24**	78	**44**	99	**49**	99	**46**	98	**52**	99	**49**	98
	Gap	**40**	16	**35**	0	**34**	0	**15**	2	**31**	1	**33**	2

Graph 6

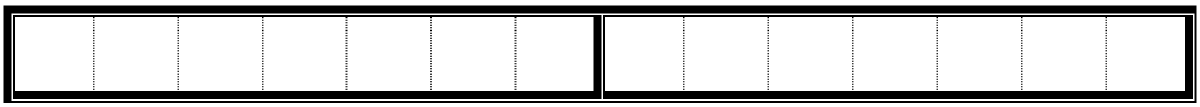


Appendix E

Problem Solving in Hannah's Classroom

Diagram 1. Ted's Method of Solving the Animal Shelter Problem

Step 1.



Step 2.

He divided each group of 7 into (because of the four groups):

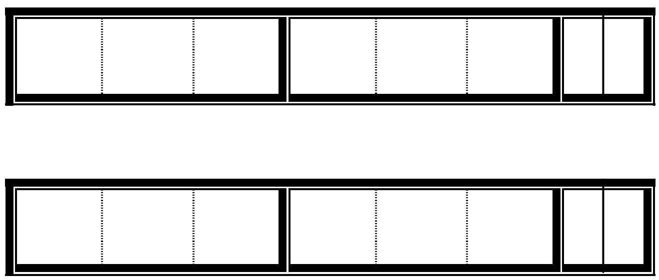


Diagram 2. Problem Solving in Hannah's Classroom

A Student's Solution using the Hangman Strategy

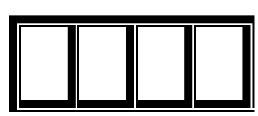
The student wrote:

$$
\begin{array}{r l}
4\overline{)\,14} & \\
\underline{-8} & 4\times 2 = 8 \\
6 & \\
\underline{-4} & 4\times 1 = 4 \\
2 & \\
\underline{-2} & 4\times .5 = 2 \\
0 & \\
 & \quad 2+1+.5 = 3.5
\end{array}
$$

A boy raised his hand and asked, "When you got down to 2, how did you know to use .4?" Dusty explained, "I knew 4×.25=1.00 so 4×.5=2.00. Hannah thanked him and Dusty returned to his seat.

Diagram 3. Problem Solving in Hannah's Classroom

One of the Native American girls draws the following:



1	1	1	1
1	1	1	1
1	1	1	1
.5	.5	.5	.5

Appendix F

Problem Solving in Martin's Classroom

Diagram 1. The girl wrote:

$$\begin{array}{r l}
14R4 & \\
38\overline{)536} & \\
-\underline{380} & 10 \\
156 & \\
-\underline{114} & 3 \\
42 & \\
-\underline{38} & 1 \\
4 & \\
\end{array}$$

14 R 4

Diagram 2. Problem Solving in Martin's Classroom

The girl wrote on the Promethean board:

$$\begin{array}{l}
38 \times ____ = 536 \\
38 \times 10 = 380 \\
38 \times 2 = \quad 76 \\
38 \times 2 = \quad \underline{76} \\
\qquad\qquad 532 \\
532 \\
+\ \underline{4} \\
536
\end{array}$$

Diagram 3 Problem Solving in Martin's Classroom

The student wrote:

10

10

5

1

The quotient is 28 R 11.

1

1

R 11

Appendix G

Problem Solving in Madison's Classroom

Diagram 1. Problem Solving in Madison's Classroom

A boy showed his strategy as: $100 \div 2 = 50$

$90 \div 2 = \underline{45}$

95

Diagram 2. Problem Solving in Madison's Classroom

A second boy worked the problem in a similar manner but organized his work differently:

190 ÷ 2

100 90

100÷2 90÷2

50 45

95

Appendix H

Teacher Demographic Information
Elementary School Teacher Survey Results

1. **Female: 97.4 % (37/38)** **Male: 2.6% (1/38)**

2. **What is your ethnicity?**

Ethnicity	Percentage	Frequency (38)
American Indian or Alaska Native	5.3%	2
Asian	0%	0
Black or African-American	0%	0
Hispanic or Latino	2.6%	1
Native Hawaiian or Other Pacific Islander	0%	0
White	92.1%	35

Table 1. Teacher Demographic Information

3. **Where do you currently teach?**

Elementary School	Percentage	Frequency (38)
Jefferson	28.9%	11
Lincoln	44.7%	17
Washington	18.4%	7
Roosevelt	7.9%	3

Table 2. Teacher Demographic Information

4. **How many years have you taught mathematics prior to this school year?**

Experience	Percentage	Frequency (38)
Less than one year	13.2%	5
1-2 years	21.1%	8
3-5 years	7.9%	3
6-8 years	7.9%	3
9-11 years	18.4%	7
12-15 years	10.5%	4
16 or more years	21.1%	8

Table 3. Teacher Demographic Information

5. What grade do you currently teach for Rapid City Area Schools?

Grade	Percentage	Frequency (38)
Kindergarten	7.9%	3
First Grade	18.4%	7
Second Grade	13.2%	5
Third Grade	15.8%	6
Fourth Grade	10.5%	4
Fifth Grade	13.2%	5
Special Education	5.3%	2
Teacher Leader	15.8%	6

Table 4. Teacher Demographic Information

6. How long have you taught at your current elementary school?

Experience	Percentage	Frequency (38)
Less than one year	7	18.4%
1-2 years	10	26.3%
3-5 years	10	26.3%
6-8 years	5	13.2%
9-11 years	1	2.6%
12-15 years	3	7.9%
16 or more years	2	5.3%

Appendix I

Teacher Beliefs and Preparedness

Table 1 Please provide your opinion about each of the following statements. Please check only one box for each question.

36 Responses	Strongly Agree (5)	Somewhat Agree (4)	No Opinion (3)	Somewhat disagree (2)	Strongly Disagree (1)	Mean	Standard Deviation	Median	Mode
I enjoy teaching mathematics.	**66.7% (24)**	25.0% (9)	0%	8.3% (3)	0%	4.5	0.878	5	5
I spend time during the regular school week to work with my peers on mathematics curriculum and instruction.	**66.7% (24)**	30.6% (11)	0%	2.8% (1)	0%	4.611	0.644	5	5
Students generally learn mathematics best in classes with students of similar abilities.	5.3% (2)	34.2% (13)	5.3% (2)	**36.8% (14)**	18.4% (7)	2.710	1.271	2	4
Teachers in this school regularly share ideas and materials related to mathematics.	44.7% (17)	**47.4% (18)**	5.3% (2)	0%	2.6% (1)	4.316	0.809	4	4
A student's culture and ethnicity has no bearing on mathematical learning.	15.8% (6)	10.5% (4)	7.9% (3)	**42.1% (16)**	23.7% (9)	2.526	1.389	2	2

Table 15 Teacher Beliefs and Preparedness

Table 2 Please rate each of the following in terms of its importance for effective mathematics instruction in the grade you teach.

37 Responses	**Very Important (4)**	**Important (3)**	**Somewhat Important (2)**	**Not Important (1)**	**Mean**	**Standard Deviation**	**Median**	**Mode**
Provide concrete experience before abstract concepts.	**62.2% (23)**	21.6% (8)	16.2% (6)	0%	3.459	0.767	4	4
Develop students' conceptual understanding of mathematics.	**78.4% (29)**	21.6% (8)	0%	0%	3.783	0.417	4	4
Take students' prior understanding into account when planning curriculum and instruction.	**67.6% (25)**	32.4% (12)	0%	0%	3.676	0.475	4	4
Practice computational skills and algorithms.	29.7% (11)	**45.9% (17)**	16.2% (6)	8.1% (3)	2.972	0.897	3	3
Make connections between mathematics and a student's culture or background.	35.1% (13)	**48.6% (18)**	13.5% (5)	2.7% (1)	3.162	0.764	3	3
Have students work in cooperative learning groups.	35.1% (13)	**62.2% (23)**	2.7% (1)	0%	3.324	0.530	3	3
Have students participate in hands-on activities to learn a math concept.	**78.4% (29)**	21.6% (8)	0%	0%	3.784	0.417	4	4
Encourage students in inquiry-oriented activities.	**75.7% (28)**	24.3% (9)	0%	0%	3.757	0.435	4	4

Appendix J

Teacher Knowledge and Beliefs

Table 1. Please provide your opinion about each of the following statements. Please check only one box for each question.

37 Responses	**I disagree (3)**	**I agree somewhat (2)**	**I totally agree (1)**	**Mean**	**Standard Deviation**	**Median**	**Mode**
An elementary age child is unable to solve math problems unless he or she has been taught problem solving strategies.	**81.1% (30)**	16.2% (6)	2.7% (1)	2.784	0.479	3	3
The most important goal of elementary mathematics is teaching children to add, subtract, multiply, and divide.	**48.6% (18)**	**48.6% (18)**	2.7% (1)	2.459	0.558	3	2,3
Children are able to learn from listening to one another's explanations.	5.4% (2)	24.3% (9)	**70.3% (26)**	1.351	0.960	1	1
Teacher demonstration is a critical part of a math lesson.	22.2% (8)	**55.6% (20)**	22.2% (8)	2	0.676	2	2
An elementary child will be unable to solve math word problems without first learning how to add, subtract, multiply, and divide.	**69.4% (25)**	27.8% (10)	2.8% (1)	1.889	0.536	2	2
Teaching children key words will help children to solve word problems.	19.4% (7)	**50.0% (18)**	30.6% (11)	1.971	0.708	2	2
Facts should be so well mastered that the child can respond without thinking if drilled.	22.9% (8)	**51.4% (18)**	25.7% (9)	1.611	0.687	2	2
Children should be taught how to break a word problem apart to help them develop problem solving ability.	11.1% (4)	38.9% (14)	**50.0% (18)**	3.222	.681	2	2

Appendix K

Teacher Beliefs and Preparedness

Table 1 Please rate each of the following in terms of your preparation for effective mathematics instruction in the grade you teach.

36 Responses	Very well prepared (4)	Fairly prepared (3)	Somewhat Prepared (2)	Not Adequately Prepared (1)	Mean	Standard Deviation	Median	Mode
Provide concrete experience before abstract concepts.	36.1% (13)	**50.0% (18)**	13.9% (5)	0% (0)	3.222	0.681	4	4
Develop students' conceptual understanding of mathematics.	41.7% (15)	**50.0% (18)**	8.3% (3)	0.0% (0)	3.333	0.632	4	4
Take students' prior understanding into account when planning curriculum and instruction.	**55.6% (20)**	33.3% (12)	8.3% (3)	2.8% (1)	3.417	0.770	4	4
Engage students in inquiry-oriented activities.	**69.4% (25)**	25.0% (9)	5.6% (2)	0.0% (0)	3.64	0.592948	3	3
Practice computational skills and algorithms.	27.8% (10)	**47.2% (17)**	25.0% (9)	0.0% (0)	3.027	0.736	3	3
Make connections between mathematics and culture.	16.7% (6)	**41.7% (15)**	30.6% (11)	11.1% (4)	2.638	0.899	3	3
Have students work in cooperative learning groups.	**52.8% (19)**	36.1% (13)	11.1% (4)	0.0% (0)	3.417	0.691789	4	4
Have students participate in hands-on activities to learn a math concept.	**72.2% (26)**	25.0% (9)	2.8% (1)	0.0% (0)	3.694	0.524783	4	4

Teacher Beliefs and Preparedness

Table 2. **Within the arena of mathematical processes, many teachers feel better prepared to guide and help develop student learning in some domains rather than others. How well prepared do you feel to provide guidance in the following at the grade level you teach?**

37 Responses	**Very well prepared (4)**	**Fairly well prepared (3)**	**Somewhat prepared (2)**	**Not prepared (1)**	**Mean**	**Standard Deviation**	**Median**	**Mode**
Lead a class of students using investigative strategies.	**70.3% (26)**	24.3% (9)	5.4% (2)	0.0% (0)	3.647	0.588	4	4
Manage a class of students engaged in hands-on/project-based work.	**70.3% (26)**	18.9% (7)	10.8% (4)	0.0% (0)	3.595	0.686	4	4
Recognize and respond to student diversity.	**54.1% (20)**	29.7% (11)	16.2% (6)	0.0% (0)	3.378	0.758	4	4
Encourage students' interest in mathematics.	**56.8% (21)**	32.4% (12)	10.8% (4)	0.0% (0)	3.459	0.691	4	4
Use strategies that specifically encourage participation of females and minorities in mathematics.	**32.4% (12)**	**32.4% (12)**	16.2% (6)	18.9% (7)	2.784	1.109	3	4

Appendix L

Mathematical Instructional Practices and Routines

Table 1. Mathematics Instructional Practices and Routines

	4 (extensively)	3	2	1	0 (not at all)	Mean	Standard Deviation	Median	Mode
To what degree do the lessons that you teach emphasize problem solving rather than computation and memorization?	**54.1% (20)**	40.5% (15)	2.7% (1)	2.7% (1)	0% (0)	3.459	0.691	4	4
To what degree do you use direct instruction when teaching?	2.7% (1)	18.9% (7)	**54.1% (20)**	24.3% (9)	0% (0)	2	0.745	2	2
To what degree is competition emphasized in your classroom?	0% (0)	2.7% (1)	13.5% (5)	**54.1% (20)**	29.7% (11)	1.892	0.737	1	1
To what degree do you teach by posing questions?	**48.6% (18)**	35.1% (13)	16.2% (6)	0% (0)	0% (0)	3.324	0.747	4	4
To what degree do your rely on a textbook series to make instructional decisions?	16.2% (6)	**29.7% (11)**	**29.7% (11)**	16.2% (6)	8.1% (3)	3.297	1.175	3	3,2

Appendix M

Professional Development

Have you completed mathematics professional development courses offered through Project PRIME and Black Hills

Yes:24 (70.5 %)   No: 10 (29.5%)

If 'yes' to question 26, approximately how many total hours have you spent on mathematics professional development offered through Project PRIME and Black Hills State University?

	Response Percent	**Response Count**
0-9	20.8%	5
10-19	16.7%	4
20-29	8.3%	2
30-39	8.3%	2
40-49	4.2%	1
50-59	0%	0
60-69	4.2%	1
70-79	8.3%	2
80-89	4.2%	1
90-99	0%	0
100 or more hours	25%	6

Appendix N

First Short-Answer Question and Responses

1. Are there any patterns that you have noticed in terms of who does well and who struggles in your mathematics classroom? If so, please briefly describe.

Every child is different!
Yes
It varies with the amount of parent support.
Students who have been exposed to inquiry based math in the past do well in the classroom.
The students who seem to have the most difficulty are those students with limited language, limited experiences, and little or no support from home.
Students who have never experience inquiry math tend to struggle at first but usually catch on eventually.
Not at this point. We recently completed our Fall MARS testing and the typical student in my class is rated as below basic at this point.
The students that have had investigations/inquiry based math have more number sense.
Yes and no, some students who struggle with computation will at times struggle consistently with solving problems, but they can be very strong in other area, like geometry or data.
yes, students who have not had investigations before and or move around a lot have more difficulty
Not that I have been able to determine
I have noticed that students that haven't been exposed to investigations and then come to our school struggle with our math.
Not yet. I can tell which students are receiving support at home.
The children who are generally lower in reading do well in math until we start our story problems.
students who have difficulty focusing and listening during the minilesson, when directions for games are given, or when their peers share strategies seem to struggle more
The most noticeable group includes students who have moved here from a reservation school, mostly because they have been taught traditional algorithms and are not accustomed to the investigative process.
Students who know their combinations have an easier time with applying that knowledge to other areas.
Those students who have support and accountability at home often do better in math. The reverse is also true.
Students who have been working with inquiry based math for prior years do better than those without.
What stands out the most is that it is difficult for our lower reading students to succeed. There is a lot of reading, writing (explaining), and communication involved. They typically have a hard time even if they understand the concept, just because they can't explain what they did as well.
No
Many of our Native American students struggle with mathematics language as well as persistance and independence. Many enter school with significant deficits.
Students who have number sense are able to develop their own strategies and better understand anothers' strategy and learn from it.

I have noticed that students respond to me as a Native person. They are more willing to work harder and like math more.
Students with no to little parental support at home. All learning is done at school, they came with little or no prior knowledge. Also students that also move alot, either within the district or from reservation to RC often.
Students struggle when they have limited experience prior to entering school. example (can't identity numerals 1-10)
The students who have had no previous exposure to numbers - cannot count to 20 – cannot make sets - etc. are the ones that struggle the most.

Second Short-Answer Question and Responses

2. Do you know where you can access information about teaching American Indian students? If so, briefly describe.

I have been teaching Native Americans for 10 years and we share lots of information right here at our school. We have trainings all the time.
no
no
My principal and math leader have attended conferences concerning American Indians and mathematics..these would be the sources I sought out first.
I am fortunate that the other MTLs in my building are Lakota. I also attend conferences concerning Native American students. I have their web sites and other recommended sites. If I have a question I can contact our Indian Ed. office. I can go on line in search of other sites. I then need to verify if it is a trustworthy site.
no
I know that we have a Native American Outreach Coordinator at our school, she would be one resource. I also am aware of a local group called Red Stone Education Group that is focused on the needs of students in our district and surrounding areas-predominantly those that are Native American.
Yes
Some websites, we also have a coordinator for the district.
yes, Indian education office
No
Professional Journals
Yes, through my building support and other professionals in my building.
yes
no
I would guess from our Indian Ed department.
Math coordinators
no
I attended a conference, but have not accessed the resources associated with that.
We have many people in our district who are there to support us and give us resources & ideas.
Through our district. There is a person that is hired that you can contact.
Notes from the PRIME Native American Conferences Journal of Native American Education
Widening the Circle: Culturally Relevant Pedagogy for American Indian Children
No
Being a Native person myself and going through the public school system here
I know the frustrations of my people. I try and keep this in mind when I teach.
Not really.
Specifically American Indian students, no, but current research in effective math instruction, yes.

Yes - through our Indian Ed Office in our district.
no
Yes, my math leader provides us with information and the RCAS have resources.
The Rapid City School District has at our administrative building a department for Native American Education.
Our math leader would be great resources.

Third Short-Answer Question and Responses

3. Have you used the Title VII resources link available on the RCAS website? If so, briefly describe.

No
no
no
n/a
No. I was not aware of this resource. However, we have a Title VII staff person, which I can go to and do.
no
Not at this point.
No
no
no
No
I have not
no
no
no
no
no
no
No.
No I haven't. I forgot that it was there.
No
No

Fourth Short-Answer Question and Responses

4. What do you think is/are the most important outcome(s) of your math instruction?

That the children are engaged and learning!!
children have a sucessful understanding of the math being taught
My students have a very solid foundation of number sense when they leave first grade.
student understanding of their thinking and the mathematical process that they used.
To become a confident, successful, independent mathematicians / problem solver

To be able to do that math using the strategies they have learn. To be able to solve
many different problem with the knowledge they have and be able to use it in life and then
next grade.
I want the children to enjoy and embrace math. I want them to see the relevance that it has in
their everyday lives and I want them to feel confident that they can solve math problems.

Students are able to problem solve instead of just memorize.
Helping students efficiently solve real-world problems that they will use throughout their life,
outside of the classroom.
that students are able to become better problem solvers using effective strategies to solve
a problem
Students need to understand how they can find the answers to their math problems and
as well as understand why it works
To have students able to confident in their math skills
making sure that each child is reached and we are meeting individual goals.
understanding the big picture
To help students become smart problem solvers, risk takers, and enjoy math
having students who can problem solve flexibly and accurately and who have confidence
in their mathematical ability
That students are able to apply mathematics when appropriate and for students
to enjoy math.
For students to become comfortable with math. For them to realize that hard work and
persistence pays off and helps with understanding.
Students' understanding of mathematical processes, not just the solution.
To get the students thinking about math, relating it to their world, and helping them enjoy it
and feel good about their abilities.
Get my kiddos thinking about math in a variety of ways!
Helping every student achieve the five strands of mathematical proficiency. conceptual
understanding—comprehension of mathematical concepts, operations, and relations
procedural fluency—skill in carrying out procedures flexibly, accurately, efficiently, and
appropriately strategic competence—ability to formulate, represent, and solve mathematical
problems adaptive reasoning—capacity for logical thought, reflection, explanation, and justification
productive disposition—habitual inclination to see mathematics as sensible, useful, and worthwhile,
coupled with a belief in diligence and one's own efficacy.
Applying what they know in problem solving. Really learning and understanding math facts by
working with them rather than from memorization. Making use of concepts such as landmark numbers
to solve problems. Accepting different ways of solving problems.
Seeing success in students eyes as they "get " math and enjoy it. Observing students in their discussions
and listening to them truly understand math and not just a procedure!
I think that is students understanding and ability to use what they have learning in other situations not just
isolation, but the NCLB says otherwise. It is all about student performance.
Students understand and can use math knowledge to solve problems.
I believe it is my responsibility to help my students gain a firm foundation in inquiry based math.
I like to help the children think and figure things out by asking questions. There is nothing more
rewarding than seeing a child's eyes light up when they have made a new discovery and have greater
understanding.
Students gaining a solid understanding of the concepts so that they may move from concrete to abstract.
For the students to have an understanding and be proficient in mathematics.
Students are involved with solving problems, sharing solutions and thinking on their own.
I want my students to be problem solvers with real-life math skills. I want them to be able
to explain their thinking in recorded form (numbers, equations) and verbally. I want for them to
have fun and enjoy math while seeing the importance of it at the same time.

Kids discover methods of problem-solving that work for them. They learn that some methods are more efficient than others and can pick what works for them.
To have my students think.